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GROWTH AND DEVELOPMENT

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INTRODUCTION

THIS NUMBER of the REVIEW is the fourth one to deal with mental and physical development. The earlier numbers appeared in April 1933, February 1936, and February 1939. The present one deals mainly with investigations published between July 1938 and July 1941.

The scope and organization of the present review have been modified somewhat. Chapters on social-emotional development and on intellectual changes during maturity and old age have been added. The inclusion of the latter chapter acknowledges that the story of intellectual change is not complete with adolescence but involves the entire span of life. The chapters on physical, motor, and mental development are organized so that each one covers the range from birth to maturity. The treatment is to be regarded as supplemented by the issues on "Psychological Tests and Their Uses" and "Mental Hygiene and Health Education," which appeared in February 1941 and December 1940. These issues include mental and physical health, aptitudes, and personality.

In the preparation of this review, as in the preparation of earlier issues on the same subject, it has been difficult to stay within the allotted space. Contributors were instructed that it would not be possible to accommodate mention of every study that has appeared since 1938; they were urged to be selective and to present a critical summary based upon outstanding studies. Even so, with the existing space limitations, it has been necessary to abridge the materials submitted and to reduce the bibliographies to a radical degree. Readers desiring additional references will find them under appropriate heads in the Index Number of "Psychological Abstracts" published each December.

ARTHUR T. JERSILD, *Chairman*
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NOTES

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CHAPTER I

Social and Emotional Development¹

LOIS BARCLAY MURPHY

IT IS SIGNIFICANT of our deepening understanding of the scope of education that a review of social and emotional development is now included in this publication. The traditional cleavage between cognitive and affective processes or between learning and attitudes toward learning has almost vanished in the last four or five years. Educational implications of social and emotional development have come into focus in such discussions as Prescott's *Emotion and the Educative Process* (129); the Jones, Conrad, and Murphy article on "Emotional and Social Development and the Educative Process" (92); and J. E. Anderson's article on "The Development of Social Behavior" (14). The insight which this approach has developed is becoming particularly active in relation to many chronic educational difficulties, such as those involved in reading. Where formerly we heard frequent use of the phrase "reading disability" we are now likely also to have our attention directed toward the emotional attitudes leading to resistances, fears, or other blocks in learning. The fact that progress is being made in helping children who are having reading difficulties through working on basic emotional problems points to the need for an evaluation of each child's areas of comfortable learning and areas of learning inhibition in terms of the emotional values of these areas to him.

In this review more space has been given to studies which are not yet published or which are published but not in generally accessible form. The writer assumes that every reader of this article can get, if desired, a copy of Prescott (129); the recent publications on adolescence of the Progressive Education Association such as Zachry and Lighty's *Emotion and Conduct in Adolescence* (171); standard texts such as Jersild's *Child Psychology* (89); Klineberg's *Social Psychology* (99); articles in *Progressive Education*, 1940 and 1941, by Lois Meek, Herbert Stolz, and others who are now making research available for teachers in brief and readable discussions, as well as Murphy's summaries of research on problems of social and emotional development in Part III of *Experimental Social Psychology*, revised edition, 1937 (118); and Charlotte Bühler's (35) chapter on social behavior in the *Handbook of Child Psychology*, revised edition.

Hunt's review (87) devoted twenty-seven pages to emotional and social development, with little concern for the genetic picture, since general principles require all the space he had available. He noted that specific, absolute stimuli such as loss of support, loud noises, and restraint of movement (described objectively) have now given way to broader con-

¹ Bibliography for this chapter begins on page 495.

cepts such as frustration, novelty, and surprise. Such shifts, he might have added, are part of a widespread interest now in looking at the meaning of any stimulus to the individual subject instead of systematically ignoring this meaning as was formerly done in the objective approach. Hunt further reported that the present tendency is to view the effects of emotion on learning, not as due to emotion acting immediately on the learning process but rather as attributable to the "distracting" nature of the emotional situation. Emotion, however, should be considered not merely as a possible distractor, which it often is, but as a source of positive motivation in learning, important in selecting what is of interest, curiosity, or pleasure, and what is to be resisted or feared—determining what will be learned by a given learner. Affective processes are also seen in intimate relation to mental activity in Rorschach studies and in such studies as that of language symbolism by Newman (124) or Schachtel's analysis (137) of the symbolism of form in relation to dynamic perception. Relationships between conative and cognitive aspects of psychological functioning are also measured in Abel's studies, especially her studies of modes of thinking (1, 2). We can expect that within the next five or ten years this type of work will result in a systematic reformulation of problems of learning in the context of social-emotional experience in which learning usually occurs and that this reformulation will be able to correct some of the deficiencies of the approaches to learning dominated to this time by a faculty-psychology and intellectualistic approach.

There are, of course, many important publications on the borderline of research, strictly defined, with which teachers and other educators should be familiar. A review of current conditions affecting children, such as that contained in the *Annals of the American Academy of Political and Social Science* (59, 149, 160), November 1940, is of great value. The changing ratio of the number of children to the number of the rest of the population is of great significance for the future social and emotional development of children. A larger number of children will be growing up in families which include old people; a smaller number of children will be growing up in families where children outnumber adults. This change may mean an increase in the type of difficulties which we find in children who spend their formative years in nonchild-oriented families, where excessive restrictions, excessive routine, and excessive demands for conformity to the convenience of adults produce stilted, dependent, or rebellious behavior.

Trends in Recent Research

Wickman's study of children's behavior and teacher's attitudes (167) stands out in the period 1925 to 1935 as virtually the only attempt to consider the relation between the teacher's judgments and attitudes and what went on in the schoolroom. This attempt was limited

to pointing out that what is considered problem behavior is largely a matter of what disturbs the teacher. During the more recent period, teachers have taken a place with parents in sharing responsibility for behavior which appears in a group of children (12). This is the central point of the studies by Lewin and Lippitt (102) on types of authority in relation to behavior of boys in a group. This recognition of the importance of teachers is looked at both from the point of view of its potential destructiveness and its potential release for the child. Members from social work and institutional circles have commented on the fact that the warm maternal interest of a teacher or matron in individual children may in itself have a therapeutic value for dependent, evacuated, and other types of institutionalized children (33). Nursery schools are also coming to realize the therapeutic potentialities of warm relations between teachers and children (20).

Along with this increased awareness of the importance of the teacher's personality has come an increased discrimination regarding authority. There is less talk of freedom with a capital "F," as if it could take care of a child's problems, and more talk of friendly, firm, understanding authority as a prerequisite for sound social and emotional development. Oddly enough the increased belief in some authority has not yet been accompanied by a new approach to the role of verbal patterns in the development of socialized conduct: there is, for instance, relatively little discussion of moral standards, ideals as mediated by parents, school, Boy Scouts, or church. Yet any complete study of social and emotional development of children in our culture would certainly need to include a consideration of the role of emotionally toned verbal patterns in character development.

Apparently those who are carrying on and publishing research have become less interested in description and measurement for its own sake and more interested in the dynamics of origins of behavior and its control. Illustrations are found in the studies of Keister and Updegraff (96) which demonstrate the possibility of changing the child's reactions to failure. The increasing number of studies of frustration and its dynamic relation to aggression may well be contrasted with the earlier descriptive studies of aggression, resistance, and the like (120). Studies of delinquents have moved in the direction of trying to understand the emotional roots of antisocial behavior and the relation of these emotional reactions to other forms of maladjustments such as neurosis and psychosis. This interest in a psychiatric approach to problems which the teachers and the court have to deal with has led to greater awareness of early forms of serious maladjustment. There has been a veritable shower of articles of schizophrenic behavior in children (54).

Reports of mother-child relationships have taken a turn toward a more sympathetic view of the situation in which parents find themselves. While it is still emphasized that children's social and emotional problems are apt to be closely related to parental tension, especially marital maladjust-

ments (19), the attitude is less that of accusing or blaming parents in the manner of "Nineteen Ways of Being a Bad Parent" and more that of looking at the whole family in terms of their needs and problems. This attitude is of course parallel to the tendency to see both parents' and children's difficulties in relation to the cultural context. The depression stimulated this appreciation of parents' problems to considerable extent, since it became increasingly evident that parents without job security could not help but have difficulty in providing for adequate emotional development of children; but this appreciation has been deepened by the increasing *rapprochement* of the social sciences and the readiness of the psychological, psychiatric, and social work groups to learn from anthropologists, and vice versa. Informal contacts with teachers do not indicate that this increased sympathy has become general except where concrete experience with specific family situations has brought deeper insight into the 24-hour "three-ring circus" that marriage, children, and work mean for most parents. The trend is reflected rather in the willingness of educators to look at themselves and at teachers as part of this cultural milieu of the child and as capable of providing some of the basic "emotional vitamins" which the soil must give to children to avoid emotional malnourishment. This willingness has grown from the patient efforts of a few leaders such as Carson Ryan, Mary Fisher, Carolyn Zachry, Lawrence K. Frank, and Dorothy Baruch to help teachers look at their relations to children from this point of view.

As yet the writer has not seen enough discussion of what a child's problem *means to him*. Both from the writer's own research and from discussion with parents it seems obvious that a child's problem behavior often has an indirect rather than direct value for his adjustment. This is exemplified by the behavior of several small boys of varying ages—two of them soil their underwear, one persists in ruining walls by drawing, two are unconscionably dirty-faced. All of them live in devoted families, and the boys themselves are cooperative, even bordering on the perfectionistic. It seems that these respective misbehaviors serve as a human escape; they demonstrate to the boys that they are not wholly "goody-goody." In one area each is a little devil, even though in all others he is willing to be an angel. Another type of problem behavior which a child has no wish to give up appears in the case of a little girl who was adored and enjoyed it, but her two older brothers were problems and occupied most of her mother's time and energy. Finally, at the late age of three, she took to bedwetting and would not respond to any of the best methods for dealing with the problem. In a projective play situation, playing with housekeeping toys, she shouted, "And the little girl wet the bed, and it's never, never, never, *never* going to be dry." Why should it when keeping the bed wet offered such good competition to the parent time-consuming misbehavior of her brothers?

All the major longitudinal studies of children—the Child Guidance Study directed by Jean Macfarlane at the University of California, the

Study of Personality Development under the Fells Foundation at Antioch College, the Harvard Growth Studies, etc.—reveal the difficulty of trying to understand the social development of an individual child apart from his physical and intellectual development. Studies of this sort which attempt to get a fair picture of “the total child” find themselves veering away from categories which split up the child into different parts and rely upon categories which make it possible to handle the relationships between these different aspects at the same time. Another illustration of the trend toward seeing a two-way street connecting problems of mental and social-emotional development is Preston’s article on the insecurity and other emotional consequences for children who are “reading failures” (130).

It is no small cause for dismay to find so little attempt to evaluate the effect of major social changes like the depression or the war upon children. We do not have at present any adequate data on questions such as the proportion of our children in the United States who are now laying good foundations for later emotional health and social participation. What proportion are now, at the age of five, ten, or fifteen, so badly skewed in emotional and social development that no help can keep them out of a reformatory at eighteen or a sanitarium at thirty or forty? What proportion are in trouble or disturbed, but to a degree which means that adequate guidance now—at the age of five, ten, or fifteen—would result in salvaging an adult personality which might otherwise be lost to delinquency or mental illness? How many of our children are developing basic patterns of feeling and behavior which will make possible happy and constructive social relationships in work and family life when they are adults? Vocational training and preparation for marriage at the high-school or college level will not help if it is imposed upon a base of insecurity, defensiveness, irritability, and competitiveness.

Subcultural Factors in Social and Emotional Development

Subcultural differences must be recognized before we pay much attention to data on development. Differences associated with economic levels have been noted in studies of intelligence tests, but we know little about the patterns of emotional development which differ in different groups. The reading of *Class and Caste in a Southern Town* (56) suggests that the metropolitan pattern of neurosis-building outlined by Horney (84) would call for considerable modification before it could be considered relevant to small-town and rural groups. Hartshorne and May’s studies in deceit, service, and self-control used three check populations of an average eastern near-coastal small-town variety; but it might be asked what connection they would have with a Mennonite community in Pennsylvania, the children of shipbuilders on the California coast, the youngsters who have grown up during the trek of Oakies to the West, or the select young people who attend the “best eastern colleges” after a carefully planned super-

vised education in select preparatory schools. We also need more information concerning, for example, the effect on emotional development of growing up in the "wide open spaces" as compared with growing up in the confinement of apartment life in a big city. It is noteworthy in this connection that Zachry's detailed study of *Emotion and Conduct in Adolescence* (171), based on studies of youngsters in New York, Columbus, and in eastern colleges, has been criticized by western observers of children who feel that the zest, vigor, originality, and exploration of adolescence are left out of the picture and that the worrisome conflicts described by Zachry are, to say the least, completely out of perspective.

Economic and geographical differences are no more important, however, than differences of family tradition. Teachers in WPA nursery schools from different parts of the country report that families of Bulgarian, Italian, and other European backgrounds, not too long in this country, give their children more affection, spontaneous warmth, and vigorous discipline than families of the parent-educated native groups (116). Families in isolated sections, as the Highlander Folk School group in Tennessee reported by Claudia Lewis (in unpublished papers), share a constant companionship with children very different from the bifurcated adult-child world experienced by children in cities. These points—the greater directness of affection relationships with parents, greater contact and companionship, and more clear-cut discipline—are emphasized by psychiatrists and clinicians as crucial to sound personality development. Oddly enough, these values have remained most stable in those groups least affected by pressure from experts either from the medical or psychological direction.

Regional studies of a wide variety of sorts which might be carried on with the help of teachers and school psychologists in different areas might contribute invaluable data to fill some of the gaps. Occasionally there is an article reflecting this type of awareness of specific cultural settings and their meaning for the child's experience. Stott's articles on Nebraska children give us a picture of rural, small-town, and city children in the Middlewest (154, 155). Lewis' forthcoming study gives a picture of Tennessee mountain children. These stand alone except for the Middletown material and that of the Institute for Child Welfare at California, which has as yet made little material available to the general educational public. More studies from different subculture areas are needed to get an adequate picture of social and emotional development in our culture. Within limits we could compensate for this lack of "adequate sampling" on a large scale by careful and critical awareness of the nature of the social-emotional "field" within which the behavior reported has occurred. Therefore, reports on studies of the effectiveness of praise and reproof must be seen in terms of the kind of school situation where the studies were made; children in a progressive school compared with children in a conservative school might reveal different principles of response to these two types of motivation in learning, just as they would show different types of attitude toward

standard competitive lures or bait. Thus the writer has observed that students in a progressive college, where individual projects usually took the place of routine examinations, did not react to a formal examination. The example illustrates the differences in attitude determined by the total field situation which are often not recorded in the notes on "conditions of the experiment" but which are greatly needed. The writer cannot agree with Hunt (87), in his otherwise helpful review of emotion, when he implies that there is no difference between classical stimulus response work and the field-oriented work of Barker (18), Dembo, and Lewin.

Physical Bases of Social and Emotional Development

As a part of the trend toward more appreciation of relationships between physical and emotional development of children in the psychosomatic literature, we find a new awareness of constitutional and birth factors in emotional development. Shirley's article (140), on the later behavior of prematures, is of especial interest in this connection. On the basis of observations on ninety-five premature children, ranging in age from six months to six years at the time observations were closed, she described "the maturity syndrome" which preschool teachers who have dealt with groups of children over a period of years may find familiar. Among other things, the premature child is more apt to be shy and attached to his mother and to appeal for help in difficulty. Attention-span is short and flitting, but he sometimes works to a point of nervous exhaustion on difficult tasks. (Chapter III contains other comments on this syndrome.) Shirley suggests that the fact that birth is often cataclysmic, unduly prolonged, or precipitant might subject the child to birth trauma which leaves a permanent record in the nervous system. The basic fact about the premature child, Shirley pointed out in summary, is that he is in the most literal sense of the term a "sensitive" child. Obviously, such factors are of basic importance for the later artistic, social, and emotional development of children.

Several longitudinal studies based on physical and social observations of large numbers of children are maturing. Evidence from the first ten years of the child guidance study (106) indicates that certain configurations of biological and environmental factors tend to produce a fairly smoothly functioning personality; other configurations produce a disturbed and disordered one. Macfarlane (106) found that it is desirable to recognize the large array of individual differences which "make for differing susceptibilities to stimulation, differing needs and different response patterns." She noted particularly differences "in morphology, size and rates of growth, muscular equipment, nervous reactivity, sensory acuity, energy level, achievements, tensional states." A child who is at either end of the distribution curve has different organic stresses to contend with, and he may develop totally different attitudes and reaction patterns toward himself and then toward others through continuous self-

comparisons with others of the group. Further, the undersized boy will feel differently about his size if his father had been guard on his college football team and expressed high hopes for a son to carry on the tradition than if his father were a teacher who wanted his son to follow in his footsteps. The particular emotional attitudes and relations to other people which grow out of physical differences will depend on other aspects of the child's equipment, the expectations of the people with whom he is associated, the adequacy of family and other supports, and the success of his achievements which do not depend on size.

The total context in which pressures are experienced will largely determine their effects. "For example, spinach in front of a child with just his mother present means he merely has to toy at it; spinach plus mother plus father means he has to eat it all promptly; spinach plus father alone means he has to try it at least; spinach plus mother plus father plus brother who is making noises at the table means he may not have to eat any of it."

Among specific hypotheses regarding adaptive responses which the Macfarlane study hopes to check are:

Certain patterns of behavior are more heavily weighted by physiological factors than by situational ones; other patterns are largely habits resulting from external pressures. For example, low energy level and mucus membrane irritability are factors in internalized and withdrawn response. Conversely, high energy level and peripheral irritability (as skin allergies) are important factors in externalized patterning (aggression, temper tantrums). Periods of rapid growth or rapidly altering structure are periods of greater vulnerability—especially the early preschool period and the later adolescent period.

Among tentative conclusions are: No normal child is completely free of adjustive devices that get labelled as "problem behavior," the average number varying during the preschool years from four to six per child. Tempers, fears, jealousy, and oversensitiveness increase to around four or four and one-half years and then begin subsiding. Since temper tantrums, fears, and jealousy occur at one age level in more than 50 percent of our children, they cannot be regarded as neurotic behavior but rather as evidence of tension. "Thumbsucking showed zero correlations with other problems and was recruited from the favorable end of the scale on practically all family variables." Fewer problems were found among children of relaxed mothers than of tense ones; speech problems were found most often in families of greater education. The older of a pair of boys is less likely to be secure in social relationships, the younger of a pair is less likely to have confidence about his abilities.

Shirley's and Macfarlane's hypotheses are not to be regarded as isolated instances of the recognition of physical bases for patterns of social and emotional behavior. Stone and Barker's (153) report on adolescent girls presented evidence that the attitudes and interests of premenarcheal and postmenarcheal girls of the same chronological age can be discriminated, and that the postmenarcheal girls show more "mature" interests. Studies of autonomic activity in relation to behavior by Darling (48), Billingslea (26, 27), and Hall's (75, 76) studies of the relation between different expressions of emotionality and the inheritance of emotionality are of importance for our understanding at higher levels. Behavior changes accompanying organic difficulties continue to attract attention from clinicians and

seem to be another potential source of insight into physical conditions underlying various emotional patterns (80).

Social and Emotional Development during Infancy and Preschool Years

Two potentially opposed points of view about infancy have been in the literature: the first may be referred to as the Gesell-McGraw-Dennis point of view which emphasized the biological basis of maturation patterns regardless of cultural pressures upon the infant (50-53, 70). As a matter of fact, Gesell and McGraw are both primarily concerned with patterns of physical coordination which, they have shown, become easily available to the child whether or not he has special or early training in these skills. Dennis is also concerned with the broader gamut of behavior including social patterns such as smiling, which he has shown do appear at normal ages whether the child has little or much social stimulation. "Minimal attention" does not interfere with the basic processes of maturation which underlie the appearance of social and emotional patterns of behavior.

The second is the approach which may be referred to simply as the clinical point of view, since both analytically-oriented and non-Freudian clinicians seem to share it—that all of a baby's earliest experiences, his satisfaction and frustration in feeding, elimination, and early motor experience, whether he is loved or rejected, whether he is handled casually or tensely, may be reflected in the structure of his social and emotional behavior as a growing child and later as an adult. Margaret Mead has aptly offered the concept of "cultural plot" to refer to the pattern which emerges from the typical frustration and gratification experiences of a child in any given culture in his contact with the family and community structure.

Actually, these two approaches are not in conflict, for the second begins where the first leaves off. The innate pressure to mature may produce during the first six or eight months of an infant's life the raw material (smiles, cooing, babbling, reaching) of social response; but the type of social personality which a given infant develops is dependent upon the total pattern of social and emotional experience. Studies of isolated, excessively deprived, or "wild" children continue to testify to the more dramatic results of distorted early experience, and the various longitudinal studies referred to previously will shortly produce detailed material on normal results of normal differences in early experience. Levy's work on maternal overprotection and also that on affect hunger are concerned with results of certain typical kinds of limited experiences of a young child (100, 101); in the first instance, overloving and overguidance of the concerned mother; in the second instance, the basic loss to the child who experiences inadequate love and contact, with resulting remoteness and inadequacy in his own contacts with both people and objects.

Closer to the Gesell-McGraw school is probably Shirley's work (140) which substantiates Washburn's (163) emphasis on the continuity of individual patterns of social and emotional response in infants. Shirley is the last to ignore the importance of social conditioning at any level, and this fact lends weight to her evidence that each baby retains his own core of recognizable selfness. Her interest in uncovering some of the congenital syndromes which might account for these individual continuities probably gave rise to the study of the syndrome of sensitivity which she found in premature babies.

The extent of influence of early experience may not be confined to tendencies to be irritable and tempery; learning attitudes also are believed by some clinicians to be rooted in broad orientations established in infancy. That is, an unsatisfying experience with food in infancy might result in a general negative attitude toward all "taking-in" experiences, including that of taking in knowledge. Early experiences in confinement in cribs and playpens may condition later attitudes toward constraint and confinement in the school situation; early pleasure or frustration in connection with order, routine, and organization may well underlie later attitudes toward orderliness and organization. Nevertheless, however the twig was bent in the first months of life there is considerable opportunity for further direction of its growth before adolescence, and it is the teacher's job to discover what kind of guidance a given child with his individual pattern of satisfactions and frustrations can take.

A third approach which builds on both of the first two is that of Erikson (62), who deals with the emotional consequences of frustration or shock which come at critical points in the child's maturing. Thus, if a child is just learning to talk or to walk, this most recently acquired activity is most likely to be disintegrated by the shock experience and to result in stuttering in one case, awkward coordination in the other. Proper rate, normal sequence, and undisturbed opportunity are important conditions for optimum development of all functions. These conclusions undoubtedly spring from Erikson's study of embryonic development, during which "each organ has its time of origin and this time factor is as important as the place of origin." If the eye does not arise at the appointed time, it will never be able to achieve adequate development; also, if an organ has once "arisen successfully from the anlage" it may be lamed or runted, but its nature and actual existence can no longer be destroyed by interrupting the growth. The organ which "misses its time of ascendancy" is doomed not only as an individual but it endangers at the same time the whole hierarchy of organs; normal development implies the "proper relationship of size and function among the body organs."

In the sequence of "developmental habits" which are the expression of changing aspects of bodily growth and increase in ability to perceive, to touch, to grasp, to master, to make social contacts, Erikson states that the child "can be trusted to obey inner laws of development, . . . which in his prenatal period have formed one organ after another, and now (as

those organs search out reality) create one behavior item after another." Each newly emerging kind of spontaneous activity brings with it its own impulses; sensuous satisfactions in expression of the impulse; a variety of channels for release of the impulse, and exploration or experimentation with its possibilities; fantasies of fulfilment, and intolerance toward frustrations; defenses against the impulse (reaction formation) and sublimations. Many developmental habits "such as sucking and biting mannerisms, finger-play involving hair, nose, etc., body-rocking, head-banging, wetting and soiling, spitting, smearing, motor restlessness, masturbation, speech mannerisms, lying, etc., become fixed under the influence of unresolved anxiety, i.e. become compulsive habits." If they then are broken, "neurosis or character deformation through excessive inhibition can result." Emotional crises arise when several threats to the child's adjustment occur at the same time and succeed in crushing his defense system. Such threats may be: (a) changes in the body brought about by growth, maturation, or sickness; (b) changes in the environment such as a birth, death, sickness, moving, change of nurse, estrangement between parents, or financial worries; (c) changes in the person's conception of his psychological status in the world.

It is well known that over 50 percent of nursery-school children show some of the common problems at one time or another and that thumbsucking, enuresis, hitting, and tempers are assumed to be normal unless they persist unduly after the preschool age (82). Recent studies from the academic side have attempted to cut deeper than the standard descriptions of social behavior. Stimulated by the results of his factor analysis of Berne's list of behavior items, Williams in collaboration with White (166) has made a study of approach-withdrawal patterns which may underlie several segments of behavior. Fite (65) was, the writer believes, the first to try to approach the child's point of view in studying aggression, and vividly illustrated the dilemma of the child confronting parental prohibitions against hitting at the same time that he must learn to defend himself. This is one of the most interesting monographs for the teacher or layman that has ever come from the pen of dissertation writers. It would be interesting to know to what extent aggression in nursery-school children is a product of the situation created when twenty-five socially immature youngsters are grouped together before they have had an opportunity to learn the rudiments of sharing, tolerant permissiveness toward the explorations of others, and respect for property necessary in our culture.

Murphy's study (119, 120) showed that sympathetic behavior went along with aggressive behavior as a normal phase of the responses of preschool children to other children, and that it varied in different groups depending on the attitudes and examples of teachers, the amounts of competitive pressure in the group, and the interpersonal relations stimulated by the age-structure of the group. The importance of teachers' personalities and behavior for the behavior of children in a group comes into focus in H. H. Anderson's studies of dominative and integrative behavior of kindergarten teachers (12).

Conn's reports of children's reactions to the discovery of genital differences present voluminous illustrations that many children take the discovery of sex differences casually and without emotional disturbance (43, 44). Levy (100), however, with equal or more extensive experience, questioned the validity of Conn's interpretations, pointing out that since Conn's material was largely based on retrospections at the age of nine to twelve, plenty of time for repression and assimilation had elapsed, and that this kind of material is not adequate to prove Conn's point.

Dynamically, the preschool period is still extremely flexible, so that it is a fruitful period in which to watch the effects of controlled social stimulation and emotional bolstering. Training in specific skills, planning for success and for amounts of failure which can be emotionally handled by the child, and putting the child into situations in which he is superior can all help to reduce chronic shyness, inadequacy feelings, and excessively emotional reactions to failure. This kind of guided development of confidence during formative years may help to prevent serious anxieties later. The preschool child is also more accessible to catharsis of conflicts, which might be severe and repressed to a point of requiring long psychiatric treatment some years later. There is need for more awareness, on the teacher's part, of the possibilities of active help of young children.

Patterns of Feeling and Thinking Rooted in Personality Structure

Even with its flexibility, the preschool period is one when social and emotional orientations take definite form related to personality structure types. A group of children who have been observed and tested through a period of from two to four years beginning with their entrance to the Sarah Lawrence Nursery School are showing that overt behavior may change rather dramatically but always within a clear personality structure which maintains its own individual form and direction as seen in Rorschach tests, painting, and other projective tests. Lerner has found that play experiments designed to bring out patterns of ego-development often reveal, in miniature, patterns which emerge clearly in the group situation weeks or months later.

Murphy finds that social-emotional orientations manifest themselves in children's play with Miniature Life Toys, plastics, and sensory toys: tendencies to be rigid or flexible, conformist or defiant, original or stereotyped, are reflected not just in the social behavior or the character of a child's constructions, but throughout his activity, with certain significant variations in areas of constraint and areas of freedom important for the pattern of emotional development of the individual child.

We may throw the development during the preschool period into relief by contrasting the child at two and at five. The independence from his mother at the later age indicates a new emotional development sometimes expressed in open rejection of her, or even phrases such as "I don't like you any more." This emotional development with its social concomitants

has so far been described only in concrete observational terms, and no systematic research study has been made, to our knowledge, of the transition from dependence on mother to a less dependent role. Yet it is reflected in such research experiences as the rejection by five-year-old boys of the Miniature Life Toys with which they played happily a year before and will play happily a year or so hence after they have gotten over being so defensive about their roles. The parallel development in girls consists in heightened interest in dolls and housekeeping, dressing up like a lady, and less attention to the block-building, car-pushing activities which they shared with boys the year before. With girls a little element of withdrawal, decreased aggression may be present, coordinate with the increased verbal aggression of boys who have achieved an identification with a masculine role.

At the elementary-school level, studies of emotional attitudes in relation to educational development have recently been focused on reading problems. Preston (130) calls our attention to the deep insecurities which may result for the child who becomes a "reading failure"; and teachers have become alert to the relation between sibling competition or other family tensions and the child's academic progress. Liss (103) recently presented papers which looked at the basic educational attitudes of the individual as part of his total emotional and personality development. An unpublished study carried out under grants from the General Education Board to Sarah Lawrence College and the Commission on Adolescents of the Progressive Education Association pointed out certain basic life patterns which affect learning: the overconscientious girl student who demands excessively rigid standards for herself to the point of blocking the possibility of getting spontaneous insights, and whose social life is overshadowed by the same drive; the quiet, feminine girl whose basic values may be domestic or social and for whom intellectuality has no appeal; the scattered, overactive students who through accumulated insecurity or early trauma are unable to focus and organize either their social life or their work. In each of these instances, basic life patterns established along broad lines direct the quality of social and emotional attitudes of the student's whole life, including her apparent capacity to learn, organize, analyze, and otherwise carry on her studies effectively.

Some studies have concerned themselves with the relation between the intellectual content a student can deal with and the emotional drives which have come to characterize his present stage of development. A student involved in conflicts with parents, and rebellion against inadequate love, rejection, or excessive control, may reflect the dominant mood of this emotional life in hostility in writing, use of strong contrasts, violent language, enjoyment of aggression in reading material, as well as qualities of tempo, disorganization, and lack of conformity to authoritarian demands of the institution.

Social patterns in a relatively free school situation among seven-year-olds are described by B. Biber and others in an unpublished study. Social

interplay was found to differ according to the relation between each individual child's needs, identifications, areas of ease or insecurity, and the suitability of one or another activity in serving these needs. At this age level, certain children tended to use all the work situations as social opportunities. This study reveals in considerable vividness the interplay of many factors. There remains the question of evaluation and philosophy. The reviewer has not seen any evidence that any school has made a careful analysis of the types of work situation which will elicit or stimulate attitudes desired by the school authorities in this country. There are reports that Soviet education includes precisely this kind of planning for the development of cooperative social attitudes. In progressive schools in this country the adults have professed to a policy of omitting competition as an incentive and of trying to give each child the feeling that he may proceed at his own pace. In spite of this official philosophy, competition is not absent from the social behavior of the children. In the study cited previously, there were children who seemed quite incompetent while others seemed to have needs too deep to permit behavior to reflect solely the noncompetitive school atmosphere.

This study by Biber has all the advantages and disadvantages inherent in an intensive study of ten children from a relatively homogeneous subculture. Studies carried out by investigators with a different frame of reference might throw light on many aspects of the "latency period" which is brought to our attention too little. Rorschach studies point out the "pre-pubertal constriction" which appears in Rorschach records. For some time the greater amount of research time given to preschool children and to adolescents could be laid to the difficulty in studying children at the elementary age; but research methods of the observational, experimental, and projective types have developed so rapidly in the last few years that there is no longer any excuse for not acquiring a deeper and wider grasp of social and emotional development in the elementary-school period. We may take a few leads from clinicians who have shown us that imaginary companions (24), detective stories (39), and the widely current comics (23) meet real and important emotional needs in school-age children and deserve to be understood instead of being ignored or repressed by moralistic adults. If we ask the single question, What emotional needs underlie this elementary-school activity? our attention will be led more sympathetically to the developmental problems of the child of this age.

Adolescence

Literature on the adolescent continues to be the most prolific and the most easily accessible, with volumes on vocational problems, emotional problems, and conduct achieving commercial publication where similar studies on earlier age levels are confined to journals that seem obscure to laymen and teachers alike. In some ways it seems unfortunate that this is the case, since most professional workers with children, whether

they work in schools, clinics, or courts, are increasingly coming to feel that problems which emerge in adolescence are simply the end result of trends in emotional response which were becoming consolidated during the preschool and elementary-school periods. The most intensive studies of adolescents are the ones carried out in California on children ten to sixteen years old and the study carried out under the Commission on Adolescents of the Progressive Education Association, largely in the East. The western study emphasized the relation between physical changes and the child's relation to his group; changing roles in the group resulting from changing rates of physical growth; and changes in confidence or adjustment following these changes in role. A shy, bookish girl of ten blossomed into a lively and gay socialite when the consciousness of early sex maturing and attractiveness to boys gave her new confidence; a popular leader of girls' sports at ten quieted down into a withdrawn wallflower when her leadership was no longer in demand, and her athletic, boyish figure was less attractive than the rounded bodies of more feminine girls. An active ten-year-old boy became a difficult problem when slow physical maturing left him "out of the swim" of social activities of the thirteen-year-olds.

In this California study, the children's efforts to gain security and to grow up in their social group are seen to be a major concern from twelve to sixteen. In the eastern study, not so many children have the early social freedom which the western children have and the reports seem to be more concerned with inner problems and anxieties. Worries about weight, menstruation, work, and relations to family all appear in the final picture but with considerable emphasis upon the child's feeling about his changing body and his changing self, his sex role, and adequacy. Doubtless, the difference in method between these studies accounts for part of the difference in emphasis on results, since the western study was based on observation of children in group activities, on tests of adjustment and attitudes, and on physical and mental measurements, while the eastern study was based largely on interviews supplemented by tests. Both are too important and extensive for any comment here to be adequate and should be classical for years to come.

Even such careful studies as these, however, do not deal adequately with the adolescent's experience in clubs, church organizations, and other institutionalized groups. An occasional study of Scouts may be found. In view of the large proportion of young people still in the churches, in spite of the increasing chasm between intellectuals and the church, it is obvious that we need to know and understand more of the adolescent's need for spiritual nourishment.

At the college level, we find Newcomb's study (to be published) of changes of social attitude in Bennington girls, in the direction which would be expected in a liberal academic environment. Sarah Lawrence is presenting a series of studies around the theme of emotional patterns in relation to learning. Abel's study of modes of thinking (2), char-

acteristic of individual students and teachers, is in the same direction, though based on observations of secondary-school children. She suggests that educational planning might well take into account a child's need to study both with a teacher who thinks the way he does and with a teacher who has a different pattern of thinking, to broaden his base. These are examples of the trend observed earlier in this review—to look at problems of learning in a wider setting, and especially in relation to the specific attitudes and intellectual-emotional patterns of response which direct a given child's learning. Further understanding of these problems is needed before we can know to whom logic, science, or art can really be taught, or why it is easy for one child to share our liberal objectivity and impossible for another to do so.

Methods of Study

In the field of emotional development the most striking emphases in the last three or four years have been those centering around the study of emotional reactions in relation to personality. Personality tests for elementary-school children have been increasing in number; some of them (22) follow lines originally laid down in the tests for adults, such as the Bernreuter inventory; others have developed along new lines suggested by a study of children themselves. This trend amounts to a bringing into the realm of the teachers and the school, methods for studying adjustment formerly confined to the college and adult level.

A similar extension into the field of study and guidance of normal school children of methods originally developed in the special field of psychiatric work has taken place in the use of play technics originally developed and described by clinicians of psychoanalytic orientation. We now find descriptions of play technics for studying the emotional patterns of normal children as well as play technics used in therapy of children with difficulties. Projective technics need not be confined to a few formally planned technics applied to get at the emotional concerns of individual students. Everything or anything a student does may be regarded as a "projective datum," just as it may be regarded from a moral or legal or educational point of view. Any teacher who knows how a student is spending his time, his work habits, his relations with people, the kind of thing he reads in leisure time, how he reads assignments, and his behavior in class and in the dining room has "projective material" out of which to build a diagnosis of the student's basic attitudes and emotional development. Specific fantasies may be more important to obtain in the case of some students than others and may or may not be needed depending upon whether paintings, drawings, doodlings, line of gossip, and other spontaneous responses are accessible. All these data may be approached with a tool like Murray's list of "needs and press" (121) or, more casually, with an attempt to discover the persistent drives, defenses, and compensations which make the pattern of attitudes. It is not within the purview of

this paper to discuss to what extent this should be done and to what end.

The possibility of accurate diagnosis of emotional difficulties seems to be coming closer to reality in Munroe's study (to be published) of the modification of the Rorschach for use in testing large groups. Tried on college freshmen, the method gave better results than the Bernreuter Personality Inventory.

The use of art technics is similar to that of play technics for studying children's emotional attitudes. A certain amount of comparative material based on drawings from individuals of different cultures gives a broader base for our understanding of the art materials than we have for play, since most of the play technics involve the use of specific objects such as dolls, housekeeping materials, vehicles, etc., many of which are unfamiliar to children of primitive cultures, otherwise accessible for comparison. Space does not permit discussion of these methods of studying emotional patterns in children, but for those who may be interested a number of illustrative references are given in the bibliography (7, 8, 55, 60, 62, 94, 117). The reader should also see the review of projective technics by Ruth Strang in the December 1940 issue of the REVIEW.

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CHAPTER II

Mental Development from Birth to Maturity¹

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THE NORMATIVE APPROACH to the study of child growth and development is still used extensively, but there also seems to be a growing realization that the factors that cause or influence particular outcomes must be studied and assessed. New technics and methods of research are being developed and the relatively intangible aspects of growth explored. The need for new evaluative procedures, including the statistical, is becoming increasingly apparent as the problem of patterns of development is commanding greater and greater attention.

Growth Studies

At Antioch College the Samuel S. Fels Research Institute is following 130 children from conception through adolescence (193). The work of the Yale Clinic of Child Development is published in a series of notable articles and books (63, 66, 67, 68). A recent publication (44) summarizes the outcomes of the Third Harvard Growth Study. The Fourth Harvard Growth Study (210) was begun by Stuart and his associates in 1930 and deals with children from birth on. The Berkeley Growth Study, which also deals with children from birth on, is summarized by Jones and Bayley (104); they include a helpful bibliography of thirty-seven titles. Macfarlane (132) has reported on the plans, methods, and technics used in the Berkeley Guidance Study. Blatz has reported studies of the Dionne Quintuplets (18).

Early Development

At the lower age levels it is extremely difficult to differentiate the various components of the behavior entity; indeed, the younger the child the more diverse the activities conventionally included under the category "mental development." Various aspects of early development have been studied by several investigators (8, 10, 15, 45, 46, 63, 65, 66, 122, 244). It seems clear that the earlier the developmental period studied the more stable are the growth factors involved and the less we know of their nature and role. Certainly branding them "maturational," "autogenous," or "relatively little influenced by experience" does not solve the problem.

Intelligence tests for the young—P. Cattell (31) has published a downward revision to two months of Form L of the Stanford-Binet tests. Gesell's "Developmental Diagnosis" (66) deals with the assessment of behavior patterns and growth trends from four weeks to three years. The revision

¹ Bibliography for this chapter begins on page 519.

of the Stanford-Binet scale (216) extends measurement down to the two and one-half year level. Nelson and Richards (154) have determined mental age values for the Gesell Schedules using assumptions of similarity of function and constant coefficients of variability. "Projective" and "Play Therapy" techniques were referred to in Chapter I of this issue. Motor development is more fully treated in Chapter V.

Prediction of Mental Growth in Infancy

There seems to be general agreement that, except in cases suffering from gross abnormalities and severe developmental accidents, the infant at birth is poorly differentiated from the group. There is also substantial agreement that the greatest irregularity in rates of growth in mental abilities occurs during the early developmental period when development is most rapid (10, 11). Opinions differ as to when fairly stable differentiations appear, but most authors are agreed that future mental test score is not accurately predicted by tests now available for children under two years of age (6, 8, 11, 29, 44, 88, 90, 154, 155). Anderson (6) has made a critical evaluation of infant and preschool tests. Hallowell (80), in trying to ascertain how early in the life history of an individual a relatively stable IQ can be ascertained, stressed the need for using all available data in making the evaluation. Some test items have greater predictive value than others. The problem seems to be complicated by the varying functions tested at different age levels.

L. Dewey Anderson (8) found that a combination of three-, six-, nine-, twelve-, and twenty-four-month age scores correlates .64 with intelligence at five years. Tests given at six months and at eighteen months show a different correlation with later intelligence than those given at nine or twelve months. Nelson and Richards (154, 155) found, among other things, that some individual items at six months correlated better with later IQ than total test scores. A factor analysis of seventeen items passed by 25 percent to 75 percent of the subjects at six months yielded tentatively three possible factors—alertness, motor ability, and testability or halo. Factor analysis of tests at twelve and eighteen months yielded at least two factors—alertness and motor ability.

The low predictive value of tests in the early developmental period has been explained in several ways: (a) It has been held that the early tests are largely motor tests. (b) It has been pointed out that "mental organization changes with growth and that the rate of change is especially rapid before two years of age" (11). (c) It is apparent that direction, rate, and pattern of growth are, for the most part, unknown under the usual testing conditions, although knowledge of these factors is essential for accurate prognosis. (d) It is becoming increasingly clear, too, that the pertinent environmental variables must be evaluated accurately and that their influence varies with the age of the child, increasing markedly from birth through the preschool period (12, 89).

Rate of Mental Growth

Freeman and Flory (60) obtained data for the same children over a ten-year period and found that individual differences with respect to the rate and form of the growth curve were very large. In a later report by Freeman (58), the variability of rate of growth was further emphasized by data showing that the rate varies at different ages in no predictable manner. Gesell (64) in a case study of several subjects selected from a group of thirty children reported that the course of mental growth did not appear erratic and highly variable, although each child tended to exhibit a distinctive growth pattern. However, Bayley (11), in a study of sixty-one children tested from the time they were one month of age, reported individual children showing variable rates of growth. From her analysis of growth curves she concluded that mental organization itself changes with growth and that such factors as tests requiring different mental functions at various difficulty levels complicate the interpretation of growth curves.

Pubescent changes and intelligence—Stone and Barker (207) compared the Otis Intelligence Test scores of 175 postmenarcheal girls with those of 175 premenarcheal girls. The girls were paired for chronological age, personality, and socio-economic status. The mean score of the postmenarcheal girls was 2.25 points higher than that of the premenarcheal girls. This difference was not considered statistically reliable. In a more recent study it was observed that the mean IQ of the pubescent girls was from .5 to 5.0 points higher than that for the prepubescent. The differences are from .28 to 2.34 times their standard error; however, such differences were accounted for on the basis of a selective factor that entered into the study (208).

Cessation of Mental Growth

Wladkowsky (253) noted that mental defectives showed a more rapid growth before the age of fourteen than after this age. There was, furthermore, a tendency for the IQ to decrease after the age of sixteen. The curves of growth show a slower ascent after the eleven-year age level. Somewhat in harmony with this are the results that have been obtained from experiments on logical learning and retention with meaningful verbal materials. The review by Welborn and English (232) included a bibliography of eighty-three titles. The conclusions reached were that such retention showed a decided increase from early life to puberty, with a slower increase after this period of life. The results obtained by Freeman (59) from applying a composite mental test to several hundred children have been verified by subsequent research. He pointed out from growth curves plotted from age eight until late adolescence that "(1) the intellectual growth curve diminishes only slightly in rate from 8 years to 15 or 16 years of age, (2) intellectual growth continues at least to 20 years and probably

beyond" (59, p. 34). Terman and Merrill (216) have suggested from their studies that the amount of mental development during the first several years of life is much greater than that of later years. They point out that the amount of development between three and four years of age approximates that between six and eight or between nine and twelve. There is evidence, however, from individual growth curves that there is an individual variation in the rate and limit of development.

Effect of Environment on Intelligence

During the period covered by this review many additional studies dealing with the effect of environmental conditions have appeared, culminating in the Thirty-Ninth Yearbook of the National Society for the Study of Education. It is not possible to summarize here the extensive data presented. The reader is asked to turn to the Yearbook and the critical analyses, especially of the Iowa Studies, which have been reported by McNemar (138, 139), Anderson (6, 7), Goodenough (72, 74, 75, 76), Simpson (185, 186), and others; and the replies by Stoddard (199, 200, 201, 202, 205), Wellman (236, 237, 239), Wellman, Skeels, and Skodak (241). One may also be interested to read the comments from the "side-lines" by Saucier (181).

To assist in interpreting the data it may be helpful to summarize the major framework into which the studies and arguments fall. First, what is the question at issue? In the past, studies have sought to find the relative contributions of heredity and environment. This purpose is not characteristic of the studies of the last three-year period. There is a growing conviction that relative percentage contributions are not meaningful. Some of the studies of the past three years have rephrased the question somewhat in the form, "Given two groups of children of equal IQ at a given moment, what will happen when these two groups are placed in radically different environments?"

Second, what are the major problems of experimental technic? These issues have made most of the literature and are somewhat lengthy.

1. In studies continued over a period of time it is difficult to avoid the dropping out of subjects. This introduces a variable as McNemar (138, 139) has well indicated. However, the data can be presented in such a way as to show the results for the constant group as well as for the total group. When the data from the Iowa Orphanage Project (241), for example, were analyzed to separate out the constant group, it was found that the 21 experimental and 22 control children who remained 400 or more days showed growth trends similar to those of the total group.

2. In retest studies there is a tendency to report the data by cases at each test period rather than in terms of the same individuals at successive test periods. McNemar (138) reanalyzed the 40 cases of experimental subjects and 65 controls in the Iowa Orphanage Project according to individuals in each group and showed that the critical ratio of difference reduces from 4.2 to 2.2. This is a valuable point. On the other hand, the same scores were divided by Wellman (241) into those above 80 IQ and those below 80 IQ in the initial test. Those above 80 IQ in the control group lost 15.6 while those in the experimental group lost 2.2 giving a difference significant at the 1 percent level. Those below 80 IQ in the control group gained 4.2 IQ points while

the preschool group gained 8.2 IQ points. The increase of the differences between the two groups at each time that they were tested shows marked consistency.

3. Intelligence tests are not sufficiently reliable so that statistical regression can be neglected. This is also an important point and must be taken into account whenever subjects are divided into high and low groups and no control groups are used. Statistical regression, however, cannot be used to account for significant differences when matched experimental and control groups are used. Also, it does not explain the shifting of means when total groups are considered. When those portions of the data in which statistical regression has not been taken account of are excluded, there remains a sizeable residue of matched group and total group comparisons.

4. Several writers have pointed out that intelligence tests at the lower age levels are not as reliable as those at the later age levels. IQ's computed for two- and three-year-old children are not as reliable as those for eight- or nine-year-old children. Also, Anderson (7) has raised the question as to whether "terminal measures" of intelligence should not be used in development of intelligence tests. However, the reliability of the lower age levels of such tests as are available is not zero and some confidence can be placed in the scores. Goodenough found a reliability of .81 for the Kuhlmann-Binet test between examinations given four weeks apart. Bayley (11) also reported coefficients in the low eighties at ages over twenty-four months. Furthermore, several years have now passed since the first measures were taken in such studies as the Skeels-Skodak (187, 189) investigation in which a fair proportion of young children were used, and data recently reported by Stoddard (200) provide remeasurements of the same children at a mean chronological age of nearly eight years with a range from five to twelve years. The results are essentially the same as those reported in the earlier Skeels-Skodak investigation.

5. In some studies, scores for two different tests such as the Kuhlmann-Binet and the Stanford-Binet are mixed indiscriminately. The effect of this can easily be shown by analyzing the data for each test separately.

6. In studies of foster children involving the measurement of foster parents, it has been pointed out that tests given to illegitimate mothers may not be reliable because of the emotional stress prior to or following birth. However, usually there is opportunity to observe the mothers in situations other than the test situation and this has led the investigators to compare the intelligence quotients as found by the examiners with behavior in other situations. Such additional data can provide a partial check on this point.

7. In estimating the intellectual level of the true parents of foster children, the use of sixteen as a maximum divisor for computing the adult IQ has been questioned. The use of sixteen as a maximum divisor was recommended by the authors of the Stanford-Binet tests, but since this has been questioned we should have more data as to whether or not the practice should be changed. Also, it has been stated that the educational level of the true parents is practically as high as the level of the general population. Such data as are available are not sufficient to establish the average educational level of the general population either for the country at large or for individual states. All that can be done is to use the best estimates now available and await results of further investigations.

8. It has been suggested that there may be a selective factor in the studies of the foster children, since only those for whom applications for adoption were received are included. This would seem to indicate that generalizations must be restricted to the type of subjects studied until further data are available to indicate what effect, if any, such a selective factor may have.

Dangers of Overgeneralization from Studies

In addition to a clear recognition of the question and the problems of experimental technic, it is necessary to point out the dangers of over-

generalization. Overgeneralizing in the nature-nurture question appeared long before the recent controversy. For example, in past years studies have been made of the growth of twins reared in different environments. If identical twins reared apart yielded a rather high correlation in factor "A," it was concluded that inner forces determine factor "A" and that environment has little effect. Now it must be noted that if the term "environment" has its usual meaning it means "any environment." But in a given study usually only two environments were tested out and compared. What would happen if a third environment radically different from the other two entered the picture? If height is the characteristic in question, what would happen if we set up an environment containing a diet loaded with hormones influencing growth? This is not beyond the realm of possibility as indicated by some of the discoveries of nutrition in the last third of a century. In other words, generalizations must be confined to the environments actually tried out and cannot be extended to *all* environments however different they may be constructed now or in the future.

This caution in generalizing applies to the studies under review. Investigators in different parts of the country have tried out the effect of preschool and special school attendance on mental growth. Wellman (240), Starkweather and Roberts, and Thorndike (in part) (224), Skeels, Wellman, Updegraff, and Williams (188) have reported such environments as producing gains in IQ. Anderson, Bird, Goodenough and Maurer, Jones and Jorgensen, Voas, Olson and Hughes, Lamson, Pritchard (citations in reference 151), Horan, and Hollingworth (170) reported no effects of the preschool environment or of special classes in school. If we count number of investigations, there are more showing no gain than otherwise. On the other hand, Stoddard (201) has summarized data showing that if we consider number of subjects, far more subjects have been used in the studies showing gains than in the studies not showing gains. However, the fact that a given school environment did or did not produce a change in IQ does not allow the generalization or expectation that all school environments will do the same. It is quite conceivable that one might obtain results such as those reported by Thorndike and others (224) in which one and perhaps two of the three environments showed a change and one definitely did not. Preschools and schools, like families, differ, and terms such as "the preschool," "the activity school," and "the family" are relatively meaningless unless further described and classified. This need for careful description applies to both the control and experimental environments. Also, it seems the description should include the important psychological factors. To characterize homes and schools as of a certain socio-economic rating is good; to classify them in terms of teacher and parental practices and attitudes would seem better.

In other words, at present we appear to be in a stage where changes in IQ appear in some environments and not in others. We have not reached the stage at which we can point to the potent factors in the environment so that another experimenter can take the descriptions and reproduce

the results. But progress in this direction is being made. Stoddard (200), for example, reported a study by Dawe in which it was shown that training in the understanding of words and concepts over a period of ninety-two days resulted in an IQ gain of 42.9 points while a matched control group lost two points. It would appear that not until investigators at several different institutions have built known (that is carefully described), contrasting environments and have put children of known characteristics in these environments can the controversy be solved.

As a further caution to avoid overgeneralizing, results of environmental studies obtained in the present state of our knowledge of child development must not be extrapolated too far into the future. If an investigator finds at any given moment that he cannot change the course of development, he cannot logically conclude that no one will ever be able to do so.

Partially as a result of such studies and controversies there has appeared an urgent need for the improvement of mental tests. As Stoddard (204) says: "At present, controversies are on matters of degree. When viewed in the light of test inadequacies they are inconsequential. With everybody using blunderbusses the game is difficult to bag."

Methodological and Technical Problems

The problems encountered in obtaining cumulative data on adolescents studied at the Institute of Child Welfare of the University of California included the following, among others:

... sampling problems arising from restriction of the study to persons who will be available over a long term; the problem of maintaining comparable techniques of measurement; cooperation problems, in controlling motivation throughout a series of repeated measurements; the problem of the effect of the investigation upon the subjects of the study; statistical problems in (a) the choice and testing of methods for the transformation of scores, (b) the determination of trait clusters or composites, (c) the restriction or consolidation of variables for correlational study, (d) the selection of relatively homogeneous groups of subjects for special analyses, (e) the development of methods for describing individual growth curves, (f) the profile study of individuals (103).

Certain problems of testing are discussed later. We may note here that it has been stated that the use of the intelligence quotient in the interpretation of the nature of mental growth entails much confusion. The rate of change of mental level has been suggested as a more desirable basic concept for such an interpretation. The increased emphasis and understanding of development in terms of changes in behavior impose upon students of child development the necessity for making frequent observations of such changes. It is this that has given rise to the increasing number of longitudinal studies. Concerning this, McGraw has stated:

Any truly longitudinal study must be conducted in such a way as to indicate the nature of the changes taking place in the observed phenomenon. It would seem, therefore, that a longitudinal study would be comprised of any series of observations on a changing phenomenon, taken successively from the moment of inception until the changing characteristic attains stability or decline (167).

Technical Problems of Testing

Technical problems of intelligence testing have been treated in a recent issue of the REVIEW (211). A critical review has also been published by Braatöy (20). From a study by Wellman (238) it appeared that the Merrill-Palmer test measures a somewhat different set of activities from those of the Kuhlmann-Binet. A study by Honzik (90) dealt with the correlation between test scores at various early age levels and scores at the age of seven on the Stanford-Binet. Jenkins (99) compared the relative efficacy of IQ with the sigma value of the test score for the subject's age group. He suggested that the latter could be substituted for the former. Comparisons between original and revised Stanford-Binet tests were reported by Reymert and Meister (175), Black (17), and Ebert (54). The meaning of intelligence was discussed at length by Freeman (59). Lewin (118) discussed the relation of intelligence and motivation.

Observations Supplementing Tests

Hildreth (83) compared observational and test records of gifted and average children. The former elicited more favorable comments from the examiner, and only one-fifth as many unfavorable comments. Brody (23) noted that demented patients exhibit such forms of behavior on the Stanford-Binet vocabulary test in a revised form as excuses and escape behavior, excessively slow responses, incomplete comprehension, guessing, mispronunciation, lack of auto-criticism, as well as lack of insight, and a rather concrete approach.

There is increasing recognition of the need for considering growth in terms of materials and units other than those presented from intelligence test results. However, one of the difficulties encountered in many studies dealing with such materials is that the results do not yield readily to quantification and neat systematization. This difficulty was noted by McGraw (136): "Certain types of data may be recorded longitudinally at sufficient intervals to include all significant changes in the developing characteristics, and yet the data will remain utterly useless for symbolic or intellectual manipulation" (p. 88).

Sex Differences in Intelligence

Nelson and Richards (154, 155), in a study of forty-one girls and thirty-nine boys tested with the Gesell items within five days of their twelve-month birthdays, found that girls were slightly superior to boys in standing alone, walking with help, walking alone, saying four words, building a tower of two cubes, using a third cube, and placing the rod in the hole of the performance box. Boys excelled in scribbling spontaneously and dangling a ring. As part of the California Growth Study, Stolz, Jones, and Chaffey (206) reported observations on the developmental patterns of boys and girls. No one general pattern was typical for this age group, although girls revealed an accelerated development as compared with

that of boys. The study by Symonds (212) revealed significant differences in interests in the different areas of life, although little light is shown on the nature of sex differences in mental ability.

Kuznets and McNemar (110) have presented a critical review of the literature bearing on this problem. Their conclusions support the viewpoint of a general absence of sex differences. However, other studies have suggested the possibility of the presence of such differences in certain types of performances. In the majority of the studies, girls are superior in language performances and school achievement in the academic subjects, with the boys showing a greater variability. Other studies bear on these problems, including one by Rundquist (180), which shows that there is a pronounced change in the significance of school marks of boys and girls as they progress from the elementary school to the junior high school. There is a continued significant relation between school marks and intelligence among girls, with a decreased correlation in the case of boys.

Family Factors and Intelligence

Roberts (179) reported a correlation of $-.22$ for number of siblings and intelligence of children. The mothers of the dumbest children commence childbearing earlier and continue it to a later age than do other mothers. As much infertility was reported among the gifted poor as among the gifted families in higher economic categories. Penrose (164) and Cattell (33) have reported similar results. O'Hanlon (160) obtained a correlation of $-.21$ between the IQ of the child and the total number of births in the family. This was based on a study of 293 children from five to eight years of age. The correlation was raised to $-.41$ in the case of twenty-eight where the families, because of the age of the mother, were regarded as complete. Bradford (21) found similar results in a sample of British population. Cattell (33) attempted to deduce consequences that may follow from falling IQ's resulting from the difference in fertility among intellectual levels. These consequences are merely deductions and depend upon the conception of the nature of the intelligence used in the analysis.

From a study of a group of 1926 high-school graduates, Willoughby and Coogan (248) concluded that the true relation between intelligence and fertility is zero or slightly positive and that the usual notion of a negative relation results from a faulty inference from the intelligence-sibling number correlation to the intelligence-offspring number correlation. Willoughby (247) also reported a study of 108 members of a college class divided at the median intelligence test scores. No difference between high and low scoring groups in living births was found. In the interpretation of these results it should be borne in mind that either high-school or college groups are select. Complete data would include lower educational ranges.

Punke (171) reported data showing that children of older parents tend to be more intelligent than those of younger parents, but the finding may be accounted for by several factors. Conrad and Jones (40) concluded from their extensive study of familial resemblances of 997 cases in 269 family groups that the average of the mother-child correlations was essentially the same as that of the father-child correlations, the correlations for both being .49. The correlation between like-sexed siblings was no higher than that for opposite-sexed siblings.

Witty—in a study utilizing case history data, mental test scores, educational records, materials present on interest and personality inventories, and teacher's ratings—did not find any significant differences between "only" and "intermediate" junior and senior high-school pupils (252).

Bilingual children—Bilingualism does not seem to influence favorably or unfavorably the mental development of children under the conditions prevailing in four investigations examined by the reviewer, including Arsenian (9). The problem is complicated by the verbal-nonverbal test relation.

Season of birth—Varying results have been found in studies of intelligence and month of birth (73, 81, 124, 167, 168). Where statistical differences have been found it has been noted that these may be influenced by ethnic or socio-economic or other complicating factors.

Socio-Economic and Occupational Status

A number of investigations, not here reviewed in detail, have confirmed findings previously reported that there are significant differences in intelligence among socio-economic and occupational levels. A critical summary has been published by Neff (152). Honzik (89) reported that the relationship between socio-economic status of parents and intelligence of children tends to increase as one goes from the three-year level to the eight-year level, which was the limit of the study. Leovinger (125) found no significant relationship between intelligence and socio-economic measures until about eighteen months, when the difference tended to become significant.

Race

Hu (92) reported that Anglo-Chinese did better than the English except for the eight to ten age group. However, he found larger differences between the two cities studied, London and Liverpool, than between the racial groups. The mental ability of the American Negro was studied by Jenkins (98) who found the differences within the two groups (Negro and white) greater than the difference between the groups. He also presented a critical review and concluded that the hypothesis of racial difference in intelligence has not been demonstrated. Hollingworth and Witty (87) discussed the difficulties involved in comparing races and listed topics for studies.

Intelligence and School Achievement

Grant (78), in an analysis of the number knowledge of 563 first-grade pupils, found a significant correlation between intelligence and the ability to count and to classify and interpret numbers, and to carry out the fundamental operations and the knowledge of geometrical forms. Conklin (39) in an interesting study compared a group of 32 boys and 33 girls with intelligence quotients of 130 or over in Grades II through VII who were failing two or more subjects with a control group having similar intelligence quotients. Case studies tended to reveal that the failing group scoring lower on a studiousness index had mothers of less favorable personalities and were rated by psychiatrists as "poor risks." Similarities between the experimental and control groups exceeded the differences.

Leavell and Sterling (115), in a study of reading patterns of sixth-grade children, found a fairly marked tendency for the less intelligent children to make more regressions, more fixations, lower rate and comprehension scores, and to have a narrower span of recognition than the more intelligent. Billhartz and Hutson (16) found a positive relation between intelligence test scores and success in academic subjects, although the relation with industrial arts honor points was negligible. Discrepancies existing between school grades and intelligence did not show any relation with extracurriculum activities in the study conducted by Remmlein (172) of the records of seven hundred high-school seniors. Nemzek (156) found that when intelligence was held constant the relation between such non-intellectual factors as the education of the mother, occupational status of the father, and age of entrance to the elementary school became almost negligible.

Traxler (227) found the language and nonlanguage factors of the California Tests of Mental Maturity to be only slightly related in a group of twenty-one eighth-grade and seventy-three ninth-grade pupils. The differences between language and nonlanguage IQ's were found to be much greater for superior than for inferior children. This is to be expected on the basis of the positive relationship found between intelligence test scores obtained from language tests and reading test scores. This is also in harmony with the findings from the study by Edwards and Jones (55) of the intelligence quotients of children from the north Georgia mountains. The trend of the differential between intelligence and achievement in low and high intelligence groups was studied by Odom (159).

Intelligence as Related to Emotional and Social Adjustment

A small but significant correlation between intelligence and adjustment is reported by investigators. Lichtenstein and Brown (121), in a study of all the children in Grades IV through VIII from four public schools adjacent to the business and industrial districts of Chicago, found the children in this delinquency area to show mental retardation and a down-

ward trend in the mean IQ's of the successive age groups. What is cause and what is effect is not clear. Griffiths and others (79) reported intelligence as a favorable factor in school adjustment. Krugman (109), in a study of more than 12,000 children given Binet tests, found the clinic children to show a higher proportion of dull, while the control or selected group showed a similar trend for the bright. Wile and Davis (246), in a study of 250 children with mental ages of ten years, found a slight relation between mental age and behavior problems. Lurie and others (130) reported a tendency for children with low IQ's to compensate for their retardation by development of social maturity beyond their intellectual level. Lorge (129) concluded that whenever paper and pencil tests are used to measure performance related to personality some significant correlation with intelligence may be expected. Mann and Mann (141) presented a recent summary of some of the best studies relating to the problem of intelligence and juvenile delinquency. This was enlarged upon by Garrison (61) the following year (1940). Studies in this area will not be covered in this review.

Mentally Retarded Children

Valentiner (229) reported that subnormals score lower than normals in hand grip and steadiness of movement tests, but they are not necessarily more fatigable. He found subnormals less accurate and showing a more rapid decline in rate and accuracy than normals in such tasks as color naming and cancellation. Spoerl (196) found feeble-minded children superior to normals of the same mental age in drawing.

Doll (49) suggested "colonies" or "hostels," such as found in other parts of the world, to fill the gap between institutions and home care. The former can care for only a small percent of the total number of feeble-minded cases. Kinder and Abel (107) prefer a "metropolitan community" setting for subnormals to the institutional. Better social adjustment seemed to result in the former. Rural ungraded schools are similarly believed superior to graded schools for both social and educational adjustment (Layman, 114). Pritchard, Horan, and Hollingworth (170) found no change in mental status of dull normal children after two years in a specially planned educational program. One hundred and eleven cases were followed. Melcher (146), in contrast, found gains in IQ for subnormal children who had a prolonged "preacademic" training in preparation for regular school work.

Gifted Children

Thorndike (222) defined "gifted" as representing the ability to work with ideas. Faris (56) pointed out a sociological factor in the making of the genius. The gifted are consistently higher in educational achievement, especially reading (83, 84). Thorndike (223) reported that gifted subjects

reveal fewer fears and worries, but less maturity in judgment of wrongs, and in interests (on Pressey interest-attitude test). Gifted children have more interests than the retarded and more of them have hobbies according to the results of Lewis and McGehee (119). Nevill (158) found that the gifted excel in expression, alertness, and similar traits.

Several follow-up studies of Terman's genius group have appeared during the period under review (217, 218). Terman and Oden in the 1936 follow-up study found that nearly 90 percent of the boys and 80 percent of the girls entered college. Of the boys entering, approximately nineteen out of twenty graduate; of the girls, nine out of ten. At least half of the boys were launched on promising careers. From a comparison of a group of 167 most successful individuals with 146 least successful individuals the authors concluded that above the IQ level of 140 adult success depends largely upon such factors as emotional stability and drive to accomplish. Special education programs for the gifted were described by Martin (143) and Alpern (4). Programs include special schools, special classes, contract method, and various forms of enrichment. The increasing of IQ's of children already superior has been attempted by McCandless (131), who carried young children through a year of enriched training.

Early Learning

At least two investigators (105, 142) have shown that feeding is related to behavior in the elementary school. Preliminary work by Crudden (42) indicated chronological age is related to abstraction ability, especially when varying degrees of difficulty are involved. Later work with 65 children ranging in age from sixty-five to seventy-eight months revealed that children having higher IQ's tended to be better abstracters and that girls were superior to boys. Lacey and Dallenbach (111) studied the acquisition of the understanding of cause-effect relationship in 160 children varying in age from five to nine years. They reported that children in school learn the cause-effect relationship by the end of the eighth year or by the beginning of the ninth without special instruction. With special instruction, however, the relationship can be learned by children at about seven years.

Welch and Long (235), in a further investigation of concept formation, trained fifty-four children to associate different species and class concept names with a cube and a cylinder. They found that concepts may develop in a vertical or horizontal direction and that it was more difficult for the children to learn the concept of a second hierarchy in the vertical direction than it was to learn the concepts of three different first hierarchies in the horizontal direction. Long (126) studied the concept of roundness in thirteen children ranging in age from three years to six years and three months and found that all his subjects gave evidence of having established the concept. Twenty action-agent concepts of college students were compared with those of kindergarten and first-grade children by Wilson (249).

Form Discrimination and Spatial Relationships

There is fairly general agreement that form discrimination by very young children is only slightly influenced by relative position, spatial orientation, or size. In a well-planned experiment with children from six to fifteen months of age, Ling (122) found simple geometric form discrimination present as early as six months of age. She also discovered this discrimination behavior could serve as a learning cue. Marked individual differences in form discrimination were reported. Leuba (117) studied the reactions of twenty-one nursery-school children aged from one and one-half to five and one-half years to elements of single geometric patterns. Long (127) studied size discrimination in young children varying from four to seven years in age. The comprehension of spatial relations in sixty-three preschool children ranging in age from eighteen months to five and one-half years was studied by Meyer (147). Three developmental stages were found.

According to the study by Werner (243), the perception of spatial relations improves with increasing mental age. The conclusions by Leyer (120) suggest that depth perception during childhood depends largely on conceptual factors, whereas certain peripheral components affect this at a later stage. Spatial orientation of boys and girls, Grades V to VIII, from rural schools of southern Michigan, was studied by Lord (128). Orientation for distant places followed somewhat that of the conventional maps and textbooks, while that for nearby places related closely to certain personal experiences. R. Cattell (32) has published a so-called culture-free test for measuring intelligence, consisting of seven subtests, perceptual in nature. Cattell has emphasized the value of perceptual tests for measuring the higher mental processes.

Language Development and Intelligence

A graphic method for the simultaneous presentation of a number of central tendencies in speech sound data was developed by Irwin (94), who studied and compared the vocalizations of newborn infants and of older groups. A study of the vowel elements in the crying vocalization of forty infants under ten days of age by Irwin and Curry (95) showed that only one vowel was common to all infants and only four occurred with appreciable frequency. The common content of speech in preschool children was studied by Shirley (183). The well-known positive relationship between language development and socio-economic status was verified by Young (257) in a matched group study of the language behavior of seventy-four children aged thirty to sixty-five months. Gaskill (62) reviewed the literature on the relationship between intelligence and language facility and reached the conclusion that no clear-cut relationship existed.

The study by Irwin and Newland (93), with 306 subjects aged four to eighteen years, was concerned with the genetic development of certain characteristic ways of naming visual figures. A study by Bennett and

Roslow (14) provided a basis for evaluating language growth through a study of norms for the Columbia Vocabulary Test extended from Grades IX through XII. Quoting opinions from 1750 to the present, Parker (162) pointed out the close relation between language expression and clarity of thought. According to the study by Millard (149), the growth of reading ability among preadolescent boys and girls approximates a curvilinear development from grade to grade.

The Ellis Visual Designs Test has been found useful for designating the extremes of visual memory and reproduction (255). A significant finding in this connection is the low correlations obtained by MacMurray (137) between the performance in verbal and nonverbal intelligence tests for bright and dull children. The correlation obtained between the IQ's secured from the tests given to the dull group was .43, while that obtained for the bright group was .23. Such correlations supported by evidence from Thurstone's tests for primary mental abilities (226) would indicate that IQ's obtained from verbal and nonverbal tests cannot be used interchangeably. Stalnaker's (197, 198) analysis of the results of tests given to freshmen and other studies such as those of Brody (22, 23) gave Traxler (227) and Edwards (55) still further support to this contention.

Memory

Dudycha and Dudycha (52) reviewed thirty-five articles and books dealing with childhood memories. They discuss the values of various methods of study. There seems to be "fair agreement that the earliest remembered experience for most people dates back to their third or fourth year." (p. 673). There is agreement also that women tend to recall earlier memories than men, the differential being some two months. Visual memories predominate and it is also suggested that a fairly high negative correlation may exist between intelligence and earliest memory. The criticism that most early memories are verbal stereotypes or memories of being told of early experiences is not dealt with effectively.

To plot the growth of memory functions throughout adolescence and youth, studies are needed to answer questions such as: Are there differences in the relative effectiveness of various presentations at various age levels? Do the effects of a given kind of material change with age? Are there differences in the phenomenon of forgetting? On the whole, experiments have not been set up to answer such comparative questions. A study by Burt (28) compared the effect of memorizing meaningless material during infancy upon relearning at later age levels. Meaningless material was read aloud frequently to a subject fifteen months of age. At eight and one-half years the learning of some of the original material was compared with the learning of comparable new material. This process was reported at fourteen years of age. At eight and one-half the relearning required approximately 30 percent fewer repetitions for the old material than for the new. At age fourteen, however, the corresponding figure had dropped to 8 percent. In numerous

studies of the effect of various methods and conditions on the memory functions, the investigators considered but one age level, hence the data do not directly contribute to development.

The phenomenon of reminiscence was positively reported by Ward (231) and by Hovland (91). However, Bunch (26) suggested certain experimental difficulties that may account in part for the apparent appearance of the phenomenon. The effect of feeling tone or affective tone on memorizing was studied by Gilbert (70, 71) and Lanier (113). Lanier found no clear-cut evidence that pleasant memories tend to persevere, while Gilbert found the tendency to remember pleasant association more evident in adults than children. Gilbert (70, 71) also reviewed experiments published since 1929 and concluded that the weight of evidence is in favor of the hypothesis of affective selectivity in memory. Courts (41), in an interesting study, reported that induced muscular tension tends to facilitate memorizing of nonsense syllables until an optimum is reached. The conditions of human forgetting were summarized by McGeoch (134, 135).

Development of Thinking, Reasoning, and Problem-Solving Behavior

An excellent review of the literature dealing with the development of thought in young children was published by Johnson (102). She pointed out that studies of problem solving have shown that the stages of solution involved are similar for children and adults and that marked overlapping of behavior occurs from six to twenty-three years of age. The thought processes of the child and the nonscientific adult are reported to be similar. Studies of children give evidence of the early development of concepts and the ability to respond to relative similarities and differences. She concluded by stressing the fact that experiences which give opportunity for, and motivate toward, the development of thought should be provided at an early age. Gibson and McGarvey (69) reviewed 108 experimental studies of thought and reasoning. Certain theoretical aspects of problem solving were discussed by Maier (140). The responses of 77 preschool children ranging in age from two years and three months to four years and eleven months to a series of fifteen pictures were investigated by Amen (5). She found developmental trends in simple enumeration (decrease), overt activity (increase), and psychological states or inner activity (increase). She also found a developmental change from literal, concrete interpretation of details to more subjective interpretation; developmental changes in motivation and interest; and a sequence of development from interpretation of a part as the whole, through four steps to the stage of complete analysis of the complete whole.

The possible effects of using subjects of different backgrounds of education and experience are not generally recognized, and conclusions from studies must, therefore, be tentative. Johnson (102), in a comparative study of children and adults in an unfamiliar situation, found considerable simi-

larity at the two age levels. In unfamiliar situations the adult often reverts to habitual forms of response which are repeated though previously found unsatisfactory. Abel and Sill (2) in comparing the thinking of normal and subnormal adolescents found that the normal adolescents' reactions were less concrete and were not characterized by the mode of instruction which was evidenced by the subnormals. Pickford (166) concluded that insight seems to develop by steps, some of which are not conscious. Differences in the suddenness of insight were found. The pre-insight period seemed to be occupied not by random trials and error but by directed thinking. Duncker and Krechevsky (53) suggested a general relationship between learning and thinking, and reported some striking similarities between thinking in human subjects and discrimination learning in rats. Christof (38), in a study of the thinking process, identified three stages—the formation of the problem, the elaboration, and solution or defeat. Patrick (163), in two studies of creative writing and creative drawing, found approximately the same stages in both: (a) preparation, the assembling of ideas; (b) incubation, repetition, modification, and selection from the associations; (c) illumination, the crystallization of the final ideas; and (d) verification and revision of the ideas selected. It would seem that the "stages" of thinking would depend upon the training and intelligence of the subjects.

In studies of the development of effective thinking, Wrightstone and others (256), Jersild, Thorndike, and others (100, 101), and Sells and others (182) gave comparisons between the performance of pupils in schools where newer teaching practices have been introduced and the performance of pupils in more traditional schools. They used the Modern School Achievement tests and a specially constructed test of "intellectual and dynamic factors in the social studies." Ulmer (228) has studied the development of thinking in connection with the teaching of geometry at the high-school level. Training in thinking has been the subject of a number of books and programs. These include a series of books by Center and Persons (35, 36, 37), Wood (254), Holmes (88), Thouless (225), Graham (77).

Boreas (23) in several studies, some of which involved the completion of pictures and stories and the interpretation of ink blots, reported that, in general, imagination as measured by the tests increased gradually to a peak at about age eighteen, declining thereafter. No appreciable sex differences appeared. Correlations between memory and creative imagination equalled .50 to .60, the coefficients increasing with age. Correlations slightly below .70 with intelligence were obtained, the coefficients increasing with age. Meier (145) found art students in general superior to other subjects in constructive imagination. Tests for imagination are suggested by Higginson (82) and Meier (145).

The most useful pictures for studying the phantasy of adolescents were described by Symonds (213): ". . . have a minimum of detail, are vague in theme, incomplete in content, and suggest characters with which those telling the stories can identify themselves" (p. 272). Bender and Vogel (13)

surveyed the literature dealing with imaginary companions and presented their own results of a study of fourteen cases involving imaginary companions. They concluded that the child uses imaginary companions to supplement deficient environmental experiences and emotional inadequacies and that the phantasied companions can be made to disappear by appropriate therapy. After comparing the thinking behavior of three schizophrenic children aged from seven to fourteen with fifteen normal children aged from two to five, Despert (47) concluded that true hallucinatory or delusional fantasies are not found in normal children.

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CHAPTER III

Mental Development and Performance as Related to Physical and Physiological Factors¹

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THE PRESENT REPORT deals primarily with studies appearing since the publication of two summaries by Jones (66) and Shock (120) in 1939. The topics covered include mental development as related to (a) structural characteristics represented in measurements of height or other body dimensions, or in assessments of skeletal maturity; (b) physical or sensory handicaps; (c) factors associated with premature birth, birth month, age of mother, birth order, etc.; (d) physiological factors such as are involved in nutrition, endocrine functions, drug effects, etc.; and (e) disease conditions, such as encephalitis, poliomyelitis, allergies, tuberculosis.

Mental Development and Structural Characteristics

Height and weight—As previously noted (66), it is usually found that a low positive correlation, rarely higher than .30, exists between the intelligence of children and their physical development as expressed in height or weight. In line with this, Middleton and Moffett (86) reported a correlation of .22 between intelligence and height and .15 between intelligence and weight in a group of 490 college freshmen. No significant relationship was found between physical measurements and scores on the Bernreuter test (85). Somewhat surprising are the results obtained by Katz (67) for 112 boys and 117 girls who received Stanford-Binet tests semiannually between the ages of three and five years. Contrary to the usual experience, no significant correlations were obtained for the boys between median IQ and height or weight. For the girls, on the other hand, exceptionally high correlations were obtained: IQ with height, .40; with weight, .34. It is probable that these findings are the result of special conditions in the selection of samples. An "unexpectedly high relation between intelligence quotient and stature" has been announced by Boas in a recent study (18), but his report gave neither the magnitude of the correlation nor other data necessary to appraise the conclusions reached.

Weight at birth—Particularly in connection with studies of premature children the question has been raised as to whether weight at birth would show a relationship to subsequent intelligence. No relation has been found in American studies by Hess, Mohr, and Bartelme (62) or by Benton (11). Brander (24), however, in an investigation of Finnish

¹ Bibliography for this chapter begins on page 546.

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children, reported a positive and linear correlation. Benton (10) re-analyzed Brander's observations and demonstrated a curvilinear relationship ($r = .23$; $\eta^2 = .35$). It is possible that varying conditions associated with nutrition and with differential mortality may be responsible for these variations in results, when children from different cultural or national groups are compared.

Dwarfism—It has sometimes been claimed that individuals markedly retarded in physical growth tend to be retarded in mental development. The evidence for this probably rests upon observations of cretins, who commonly show a reduction in intelligence if the hypothyroidism is so severe as to result in dwarfism. On the other hand, dwarfism from other causes, such as pituitary dysfunction, may involve no necessary alterations in mental development (50).

Skeletal maturity—Measures of body dimensions at a given age may be influenced not merely by the various hereditary and environmental factors which determine size but also by individual differences in physiological maturity. A more direct index of maturity is provided through assessments of skeletal ossification, based on X-rays. Earlier studies in this field, employing children, have been extended by Flory (43) to the college level. Since ossification of the carpal bones is practically complete by the age of seventeen years, the criterion of skeletal maturity used in his investigation of ninety-five college freshmen was the degree of closure of the radial and ulnar epiphyses of the right hand. Flory reached the conclusion that academic achievement in the freshman year is influenced by maturity factors; the skeletally less mature students tended to earn lower grade point averages even though they were slightly superior in intelligence scores. None of the relationships found, however, was statistically significant.

Capillary structure—The microscopic structure of the fingernail capillaries has received considerable attention in the German literature. The original contention of Jaensch (64) that mental retardation is closely related to capillary changes has not been borne out by subsequent investigations (see review by Suckow, 128). Several reports (70, 71, 72), however, have shown that in severe cretinism characteristic changes occur in the nail capillaries; these may respond to thyroid therapy, even though the mentality does not improve. Wittneben (136) believes that the capillary picture is useful in distinguishing between feeble-minded adolescents who will respond to organic therapy and those who will not; he recommends sterilization for the latter group. Except in the case of cretinism, competent investigators in this country have failed to find any clear-cut relations between capillary characteristics and mental defect (70).

Physical Defects and Scholarship

While a relationship between mental retardation and physical defect is well established, most of the studies reported in this field have not been

able to furnish clear evidence of the nature of the relationship. For example, it is commonly reported that cases with physical defects tend to be weighted with lower scholarship. A recent study by Woofter (137) of primary-school children confirms this finding, in demonstrating poorer average grades for children with infected tonsils or with various other types of physical or sensory defects. One cannot conclude, however, that the defects are responsible for the scholarship impairment, since to unknown degrees the relationship may be influenced by common hereditary factors, expressed both in mental and physical development, by factors associated with socio-economic status, and by various modes of interaction of these. It seems probable that some effect is exerted by physical defects through irregularities in school attendance, since children with infected tonsils, for example, were found to have a much larger number of absences than those with normal tonsils. Lee and Nemzek (73) have attempted to meet some of the criticisms of earlier studies by comparing school achievement of three hundred children suffering varying degrees of physical defect with achievement in a control group equivalent with respect to mental rating, grade location, curriculum, age, sex, and occupation and nationality of parents. A matched pair technic was used. Significantly better marks in mathematics, English, social science, general science, and health were obtained by the girls without physical defects than by those with defects. No differences were found in the case of boys. Unfortunately, the kind or seriousness of the defects was not stated. The sex difference in the relation of physical factors to achievement may possibly reflect a tendency for girls to work nearer their maximum capacity. This would result in the common finding of a superior scholarship for girls as compared with boys when working under normal conditions. It might also result in a greater susceptibility of girls to the effects of physical handicap, since they would have less "reserve" capacity to use in compensation.

Sensory Defects and Intelligence

Among studies concerned more specifically with sensory handicaps, Dispensa (44) used the Snellen Project-O-Chart to test 4,314 subjects in elementary, junior, and senior high schools of Santa Barbara, California. She found no significant differences between the visually handicapped (vision 20/40 or 20/100) and the normal groups with respect to average intelligence, reading ability, and grade placement. The hypothesis that sensory defects offer indication of generally "inferior stock" receives no support from measurements of intellectual capacities of blind or deaf children. Hayes (57) has demonstrated that because of good habits of attention to auditory stimuli, blind children actually excel normal children in certain memory functions such as memory for digits backward and memory for disconnected words. On the other hand, there was no evidence for general compensatory superiority in memory among the blind, and the conclusion was reached that compensation in the blind is the reward of effort rather than a "special gift."

Deaf and hard-of-hearing children—Comparisons of deaf with normal children have not always been in agreement. As in other cases of physical defect, if a survey reveals an apparent mental retardation among deaf children several questions must be answered before an interpretation can be reached. Has the investigator succeeded in obtaining a representative sample rather than merely an institutional group which should not be compared with norms for a general population? Has he employed tests which are independent of auditory cues or auditory experience? Has he eliminated individual cases of pathology in which the sensory defect and the mental retardation are both due to some common factor such as birth injury or infection?

In a study of performance on the Porteus maze, Zeckel and Kolk (140) matched 100 congenitally deaf children with 100 normals, on the basis of age and socio-economic status. At each age level from seven to fourteen years the deaf children were inferior, leading to the conclusion that "deafness creates a mental backwardness which impedes also the development of regions of the intellect other than those developed by speech." Goodlett and Greene (53) have reported lowered scores on five nonlanguage tests administered to colored deaf and blind children in a West Virginia institution. Since the scores obtained were compared with norms from non-institutionalized white children, it seems probable that the differences are not wholly due to the factor of sensory defect. Studies by Springer (126) with the Goodenough drawing test and by Pintner and Lev (101) with nonlanguage intelligence tests have failed to indicate inferiority in deaf children; in the latter investigation, however, hard-of-hearing children obtained slightly lower scores on verbal intelligence tests. This was attributed by the authors to social rather than to intellectual factors. An extensive summary of psychological experiments with the deaf has recently been made by Cutler (40).

In the classroom situation, progress may be impaired by inadequate hearing. For instance, Caplin (32) has found that 42 percent of the hard-of-hearing children in the elementary schools of New York City were retarded one grade or more. After receiving six months to two years of instruction in lip reading, only 5.8 percent of a group of 4,566 children showed retardation of one grade or more. In spite of the lack of quantitative assessment of the degree of hearing impairment, this study offers a strong argument for the intellectual normality of the hard-of-hearing children. Bridgman (25) has reported on eighty-three children who were sent to a clinic because of scholarship difficulties or other failures in school adjustment. While mental retardation was apparently a factor in some cases, the author emphasizes the necessity of taking into account other factors, such as unfavorable combinations of cultural-economic conditions, or brain injury or disease causing disturbances other than deafness. The importance of this latter factor has been emphasized by Winnewisser (135) who found that where mental retardation occurs in conjunction with deafness this is often attributable directly or indirectly to birth injuries.

Premature Birth and Mental Development

The weight of accumulated evidence indicates that premature birth, with its denial of the later stages of intra-uterine existence, has on the average no handicapping effects upon later mental development. It is true that Schöberlein (112) reported mental retardation in six cases out of a total of ninety-six premature infants who were studied at ages ranging from six to eighteen years. However, the range in IQ was within the normal zone, and it is clear that the diagnosis of mental retardation was based more on school progress and reports from teachers than on the actual objective measurements of intelligence. Investigators who find a greater incidence of mental defect among prematures should scrutinize their data with reference to the adequacy of the sample, for it is sometimes easier to assemble cases from an inferior socio-economic selection, as from a clinic or a public institution, than to obtain a group representative of the general population. Moreover, if the sample of prematures is weighted with cases that have suffered from minor birth injuries, it will be difficult to distinguish between the effects of prematurity *per se* and the effects of cerebral injury; wherever possible, cases with known pathology should be excluded or considered separately. Various investigators (8, 11, 55) have reported normal intellectual development in prematures beyond the age of three years. In a critical review of the literature, Benton (10) concluded that "most of the reliable studies indicate that as a group prematurely born children are not inferior to full-term children in respect to intellectual development."

Premature children have been said to show an increased weighting of various types of behavior disturbances (23). Brander, however, was unable to prove a relationship between birth weight and the incidence of such traits; since a high incidence of familial mental disorder was observed in the sample, there is little basis for the assumption that premature birth rather than other causative factors led to the disturbances later noted.

Shirley (118) has described what she called "a behavior syndrome characterizing prematurely born children." This syndrome includes an array of characters ranging from "auditory and visual keenness" to "brief attentivity, distractibility, irascibility, stubbornness . . . shyness and dependence on the mother . . . perhaps high and versatile esthetic interests." The subjective character of such traits and the absence of procedures for their quantitative evaluation makes it difficult to assess the usefulness of the concept of a "prematurity syndrome."

Season of Birth and Intelligence

Since the earlier studies by Huntington and by Pintner and his associates (reviewed in 66), reports have continued to appear on the relationship between intelligence and month of birth. Pintner and Forlano (100) have assembled data for approximately 3,000 cases in the southern hemisphere

(chiefly Australia); while little is known about the sample, it appears to be a randomly selected school population. Although no reliable differences were found, the obtained IQ's were slightly lower for children born in winter than in other seasons, agreeing with comparable records from the northern hemisphere. In a careful sampling of Scottish children, Rusk (110) showed a slight tendency for those born in February to have lower IQ's than those born in August; again, the differences are not statistically reliable. The surprisingly consistent findings in this field have been explained by Goodenough (52) in terms of (a) the known relation between socio-economic status and intelligence, and (b) a seasonal differential in frequency of births among children of different socio-economic groups. This explanation is supported by the fact that when children were classified according to paternal occupation those in lower occupational groups were found to have a fairly uniform frequency of births in the various seasons, while those in higher occupational groups showed a higher frequency of births in those months already recorded as being weighted for higher average IQ's. Goodenough's interpretation would seem to be in accordance with the fact that in samples which are relatively homogeneous with regard to social status, birth month variations apparently do not occur in IQ; this is illustrated in the negative findings for college students by Held (60), Forlano and Ehrlich (49), and Clark (36), as well as by the negative findings in studies of the feeble-minded (91).

Birth Order; Maternal Age

Previous reviews have indicated that where other factors are adequately controlled, IQ is unrelated to birth rank in normal populations. Subsequent studies have corroborated this conclusion (43, 104). This statement is not contradicted by the reports of increased incidence of birth injuries in first-born children (97) or the higher incidence of Mongolism in later born children (98). Recent studies tend to confirm the earlier belief that advanced maternal age is an important factor in the incidence of Mongolism. According to Penrose, "the probability that a mother will have a Mongol child is more than doubled for every increase of five years after 25 years of age." Dayton and Truden (43) studied 23,422 families of public-school children and, after making due allowance for family size, concluded that maternal "exhaustion" (as indicated by advanced age at the birth of the child) contributes to the production of imbecile as well as Mongol children. Although mental aberrations associated with birth injuries tend to be more frequent in first-borns, Malzberg (82) could find no evidence that the incidence of dementia praecox or manic depressive insanity in later life was related to birth order.

Anoxia; Asphyxia at Birth

Although birth injuries resulting in cranial hemorrhage are known etiological factors in motor and mental impairment, asphyxia prior to or

during birth has only recently been recognized as a possible factor. Yant and others (138) and Courville (38) have shown that repeated anoxia of the central nervous system may result in mental deterioration even in adults. Schreiber (114) examined paranatal records of 252 mentally defective infants and children for whom there was no history of inherited defect, infection, or trauma unassociated with birth. Seventy-six percent of these cases were found to have a history of asphyxia at birth. Since many of the drugs and anaesthetic agents used to produce analgesia and amnesia in the mother at birth depress respiration in the fetus, it is clear that controlled studies are needed with regard to the effects of anoxia upon subsequent mental development.

Dietary and Nutritional Influences; Vitamins

Relationships between either qualitative or quantitative inadequacies in the diet and mental development are difficult to evaluate in humans because of the difficulties in controlling cultural and other factors which may be correlated both with diet and with mental development. Seymour and Whitaker (117) reported a clinical study of fifty underprivileged children six and one-half years of age. The children were divided into two groups of the same average intelligence. The experimental group was provided at school with breakfast of fruit juice, porridge made with milk, fish or eggs, brown bread and butter, and cocoa made with milk. The control group had their usual inadequate breakfast of bread and tea at home. The two groups were taught in the same class throughout the duration of the experimental period of eight weeks. During this time arithmetic and English grades showed 7 to 10 percent more gain in the experimental than in the control group. The output of the experimental group in standardized tests, such as cancellation, showed more improvement than in the case of the control. Differences in mental output were not apparent until the tenth day of the experiment, and the test scores of the experimental group diminished again within a week after the breakfast was discontinued. Although one is tempted to conclude that the improvement in mental performance was due specifically to the improvement in nutrition, procedures of this type always involve a complication of variables; it is difficult, for example, to know to what extent the experimental group may have been influenced in the direction of better rapport or stronger motivation, merely through the fact of membership in a group that was receiving special attention.

O'Hanlon (92) reported a correlation of .18 between nutritional state and IQ in a group of 293 children from slum areas. It is possible that such a relationship is not general but occurs only among economic marginal groups with gross dietary inadequacies. Bills (16) has reported increased mental fatigability among malnourished children (as measured by number and length of "blocks" in color naming).

Vitamins—Colby and others (37) have reported acceleration of development by the administration of additional amounts of vitamin B (prepared from a water extract of rice polishings) to 25 artificially fed infants five and a half weeks of age. At six months the experimental group showed superiority in 59 of the 64 items tested (such as visual pursuit, sustained fixation, eye-hand coordination patterns, and prehension) over a control group of similar socio-economic status. When the same children were retested at nine months of age the experimental group was superior in only 46 of the behavior items, and at twelve months the two groups were equivalent in performance. Although histological evidence is completely lacking even in animal experiments, the authors believe that the behavior differences may be accounted for by the stimulation of more rapid neural myelinization.

In an experiment covering four months, Lemmel (74) found that daily administration of 100 mg. of ascorbic acid (vitamin C) to 110 institutionalized deaf mute children resulted in improvement in "general efficiency" of 48 percent of the group as reported by twelve different teachers, in contrast to improvement reported in only 11 percent of a control group. The teachers' reports indicated gains in attention and alertness rather than in actual performance. Since no standardized tests were applied and since the "control group" was on a diet somewhat deficient in vitamin C, it does not follow that increased vitamin C intake in all children will result in improved mental performance. Other studies with mental defectives (76) have failed to show improvement in mental condition following vitamin administration, although improvement was noted in appetite and other aspects of physical condition.

In animal experiments, more severe degrees of vitamin deficiency may be produced than is possible in human subjects, and more adequate controls can be maintained. Recent studies by Biel (15) have shown that severe starvation in rats resulted in impairment of learning ability, which, however, did not persist when the animals were tested at later ages (14). Studies which have shown deleterious effects of vitamin B deprivation on maze learning in rats (103) are open to some criticism because of the low motivational level, impaired appetite, generally poor physical condition, and poor motor coordination of the deficient animal. Wickens and Biel (132) have attempted to meet such criticisms by showing that vitamin B₁ deficient rats were significantly slower in acquiring a conditioned eyelid response than were normal animals. This study led to the conclusion that vitamin B₁ deficiency may have harmful effects on the developing nervous system itself. Whatever these effects may be, at least in the case of B₁, they apparently do not result in permanent damage, since animals cured of pellagra have shown normal learning ability in a maze problem (123). Recent studies by Patton (95) and Patton and Karn (96) reveal a high incidence of sound-induced convulsive seizures in rats maintained on a vitamin B₁ deficient diet. These results indicate the necessity for careful control of dietary conditions in animals used in such studies as those con-

ducted by Maier (81) on "experimental neurosis," so-called, or on "experimental epilepsy."

Effects of Thyroid on Mental Development

Improvement in mental capacities following thyroid therapy occurs in some but not all cretins (27, 111, 115). Brown, Bronstein, and Kraines (27) have made repeated observations on a group of twenty-nine cretins over a period of seven years. All the subjects with an IQ over 70 had begun treatment before the age of four years; some, however, who received treatment at an early age remained severely retarded. Even though complete mental normality cannot be restored to all cretins, with early and persistent thyroid treatment it seems that the social adjustments of such children are improved by glandular therapy. McDonald, Brown, and Bronstein (79) found among the previously mentioned group of cretins that patients between the ages of one to seven and seventeen to twenty-one years seemed to have made the best social and family adjustment. This is perhaps because the younger cretins are still considered babies by parents, while the older ones are accepted because they are able to take care of themselves and cause little trouble. Cretins between the ages of seven and twelve are reported as having the most difficulty in adjusting to other children. Thyroid therapy has been effective in improving social adjustments, since with even a modicum of physical improvement the patients are more readily accepted by other children and especially by their parents.

Sontag and Richards (124) reported that in young children "behavior changes, such as increased alertness, activity and aggressiveness occur before a marked change in skeletal development can be demonstrated when thyroid extract is fed." It is, however, generally believed that osseous retardation is more apt to respond to thyroid therapy than is mental retardation (133). Schreiber, Bronstein, and Brown (115) reported rapid development of language facility in certain cretins under thyroid therapy.

Crile (39) has recently expanded further on his general thesis that "variation in the size of the brain, the heart, the thyroid gland, and the adrenal-sympathetic system is the sole cause of the variation in the intelligence, power, and personality of wild and domestic animals." Crile argues that the relatively large brain of man requires a larger thyroid gland for the maintenance of constant oxidations, while smaller adrenal glands are required for the emergency release of energy. He sees in the increasing incidence of thyroid, heart, and vascular disorders evidence that evolution cannot continue further in the direction of a larger thinking brain and larger thyroid gland. This concept receives small support from experimental studies on the relationship between thyroid function and intelligence either in animals or in humans under normal conditions. Since the basal metabolic rate is commonly considered as an index of the functional level of activity of the thyroid gland, we should expect to find a significant correlation between intelligence and metabolic rate if the above hypothesis

is correct. Hinton (63) has reported correlations of the order of .80 between Binet IQ and basal metabolic rate in children at ages six, seven, eight, or nine years. At ten to eleven years the correlations drop to about .70, and at the twelve- to fifteen-year level the correlations are about .50. These results are in disagreement with similar measurements made on adolescents (122) or college students (45, 94). Other studies on institutionalized or clinic children aged six to twelve years have yielded extremely low or zero correlations (75, 109). On the basis of our own and similar studies the reviewers have concluded that slight variations in functional activity of the thyroid gland are not reflected in changes in mental capacity, for in most individuals other adaptive mechanisms are present which serve to compensate for this thyroid deficiency. However, as the thyroid deficiency becomes more and more acute, a point is reached beyond which compensation is not possible, with the result that mental retardation occurs as a symptom. Further experiments should be made on young children with carefully controlled metabolism determinations to see whether a significant relationship is present at a time when structural development is taking place in the nervous system.

Carefully controlled animal experiments have been also, for the most part, unsuccessful in demonstrating close relationships between thyroid and mental functions. Brody (26) reported no significant change in reaction time in adult rats fed thyroid hormone, even though the basal oxygen consumption was increased as much as 50 percent in individual animals. Partial thyroidectomy with slight diminution (5 to 26 percent) in basal oxygen consumption caused a slight (statistically insignificant) decrease in speed of reaction. Morrison and Cunningham (90) reported an impairment in establishing a conditioned response in cretinous rats; this was removed by administration of thyroid. Russian and Japanese investigators have had more apparent success in getting positive results as, for instance, in the finding that thyroidectomy makes conditioning impossible in rooks (131), or that feeding thyroid increased the speed of learning a delayed reaction in rats (as shown by Y. Nomura in the Sixth Congress of the Japanese Psychological Association, 1938).

Intelligence of Diabetics

Considerable attention has been given to the intelligence of diabetics. Since the last review was written (120), additional evidence has appeared to substantiate the conclusion that the distribution of intelligence is the same in children suffering from diabetes as in normal samples, if socio-economic factors are controlled (29, 80, 130). It should be emphasized that most of the physiological effects of diabetes (low blood sugar, coma) tend to result in impairment and damage to mental functions (2, 6), while selective factors such as socio-economic status tend to present investigators with samples of children having better than average intellectual capacity. Disregard of the horns of this dilemma has resulted in disaster to the

interpretation of test data on diabetic patients. Baker (2) has summarized the clinical literature and has reported four cases of his own in which insulin shock in diabetics produced permanent functional damage of the central nervous system.

The increasing prevalence of the use of hypoglycemic or anoxic shock treatment (for schizophrenia) has raised questions as to the possible mental effects of these treatments. Graham (56) reported improvement in test scores made by sixty-five mental patients after hypoglycemic shock therapy. The test used included the abbreviated form of the Stanford-Binet, the Rorschach, the Kent-Rosanoff association test, and a series of manual tests. Most evidence of improvement was found in the Rorschach, with least improvement (if any) in intelligence.

Pituitary Gland and Sex Hormones

Among the known physiological effects of the pituitary gland are the regulation of skeletal growth ("growth hormone") and sex maturation ("gonadotropic hormone"). Deficiencies or excesses may occur in either factor. As previously noted, studies made on dwarfs, in whom there is good reason to believe pituitary dysfunction is the underlying cause, show normal mental development (50). One case of gargoylism was found with normal intelligence, so that it is certain that mental deficiency is not necessarily associated with achondroplasia of pituitary origin. No evidence has been found in other studies to corroborate the conclusion that there is an apparent correlation of anterior lobe activity with mental development (103). In animal studies, Burnham and Leonard (30, 31) could find no evidence for impairment of learning ability or of retention after removal of either the pituitary gland or the thyroid, or both.

In seven patients with retarded sex development and obesity (Fröhlich's syndrome, thought to be due to pituitary dysfunction and deficiency in gonadotropic hormone), Schott (113) found a median IQ of 132, with none below 100. From these results we may only conclude, as in the case of pituitary growth dysfunction, that intellectual retardation is not necessarily a concomitant of gonadotropic deficiency.

If sex hormones play any extensive part in mental development, significant differences might be expected in mental test scores made by males and females, at least at certain ages. Kuznets and McNemar (69) have critically reviewed the acceptable studies of sex differences in intelligence test scores, concluding that the weight of adequate evidence is against the existence of reliable differences. Many of the studies reviewed by Kuznets and McNemar share the common weakness of drawing conclusions from small differences that lack statistical significance (107). It is of course well established that cases of marked precocity in sexual development do not usually show a corresponding mental acceleration (127). There is, indeed, a tendency for such cases to be mentally retarded. That such is not necessarily the case is indicated by the data of Benton and Hagmann (12),

who reported a normal subsequent mental development in two girls who began to menstruate at seven months and at two years, respectively.

Age at menarche—Reymert (105) found no correlation between age at menarche and intelligence in a group of 138 girls in whom the exact year and month of first menstruation were recorded. In 28 girls, the age at menarche was also unrelated to the incidence of behavior problems. Of some methodological interest is a correlation of only .77 between actual age of menarche and the age as recalled by the subjects one to three years following the event (10 percent were in error by more than twelve months). This finding raises serious doubts as to the reliability of various studies in which recalled menarcheal ages have been used.

Effects of Benzedrine on Mental Performance

It is not the purpose of the present review to consider systematically the effects of drugs on mental performance or development (see Spragg, 125). However, the increasing use of benzedrine sulfate, and the many claims made for its efficacy as a mental stimulant, make it advisable to consider some of the recent experimental studies. In previous reviews (119, 121), it was concluded that there was little objective evidence of an increase in mental output or increased learning ability with the ingestion of 10-15 mg. of benzedrine sulfate but that subjective feelings of fatigue and boredom were diminished. Further experiments have provided additional evidence to support this conclusion. For instance, Barmack (3) found no improvement in intelligence test scores among college students on Form A and B of the Otis self-administering test ninety minutes after the administration of 10 mg. of benzedrine sulfate. Nor was attention span in thirty-two subjects altered under similar dosage (5). Fifteen mg. of benzedrine sulfate, administered under controlled conditions to fifteen subjects, had no effect on fatigue in color naming or on the incidence of "blocks" (13). Scores on a syllogistic test of reasoning were not significantly improved by 10 mg. doses of benzedrine (1, 59). In animal experiments, where larger doses of the drug may be used, actual impairment of learning has been reported (46, 87). That at least some human subjects can take the drug daily in large doses (70 mg.) for two or three years without apparent injury was demonstrated by Bloomberg (17) in a study of three patients with narcolepsy.

Using a series of motor tests, two groups of investigators (22, 41) were unable to show significant results from benzedrine administration; the tests included tapping, mirror tracing, reaction time to visual stimuli, and letter cancellation. On the other hand, in experiments by Barmack (4), 15 mg. doses of the drug diminished errors in a motor test (pursuimeter); the subjects, moreover, reported less inattention, boredom, or irritation with the work and less fatigue or sleepiness. Carl and Turner (33, 34) also found evidence for increased persistence of effort, with administration of benzedrine. They conclude that there is a "favorable reaction in mood,

feeling tone, or affective attitude and this reaction, in combination with various degrees of stimulation in a physiological sense (rise in blood pressure), favors performance in tasks which call for alertness, persistence and freedom from fatigue."

Bradley (19) and others (20, 21, 22) have reported beneficial results with respect to behavior and school performance in children following the administration of 10-15 mg. benzedrine sulfate per day. Teachers noted increased attention to work and greater spontaneous interest in class work among children receiving this drug (19). Henry (61) reported that in fourteen behavior problem children with abnormal electroencephalograms "behavior was markedly improved by benzedrine and to a lesser extent by dilatin" but with no specific effect on the electroencephalogram. Cutts and Jasper (42) found clinical improvement but no effect on the electroencephalogram in twelve similar cases. In all these reports, the subjective estimates of improvement in behavior could not be corroborated when controlled testing procedures were applied.

Experiments with benzedrine have shown wide individual differences in rate of absorption and sensitivity to the drug, so that future experiments should include physiological measurements, such as blood pressure, to demonstrate the effectiveness of the dosage applied in each subject tested. More experiments are needed to discover the optimal dosage and time of maximum effect after administration of the drug. Until such basic questions are more adequately answered, the general use of benzedrine for its supposed mental stimulation should be regarded with suspicion.

Phenobarbital and Other Chemicals

The clinical use of sodium phenobarbital for the control of epileptic seizures gives practical importance to studies of the effect of this drug on learning and mental development. When the drug is administered in moderate doses to mature rats no impairment in learning ability is apparent (47). Errors are not significantly affected (93). Near lethal doses of the drug injected at the end of each learning trial produced impairment in even adult animals (134), although the experiment failed to demonstrate the physiological or psychological character of the impairment. That the drug may have definite deleterious effects on later learning ability when injected into young developing animals is suggested by Mendenhall (83) who administered large doses (as much as 100 mg. per kg. body wt.) to thirty-day-old rats. The dosage continued every 48 hours for 220 days. After a period of 40 days, during which no injections were given, the animals were tested with respect to maze learning and "reasoning." Those subjected to the drug during early development (but not during the learning tests) were definitely inferior to the controls in the learning functions studied. Although the doses used were large and the period of administration long the deleterious effects on later mental development are sugges-

tive; additional controlled experiments should be conducted, with more nearly therapeutic dosages.

Metrazol—Loken (77) subjected rats to convulsions with metrazol injections after they had learned a simple alternation habit but was unable to decide from his data whether the increased time and errors required for learning after a nine-day interval was due to the drug effect or to selective forgetting. Ziskind, Loken, and Gengerelli (141) have recently found evidence of deleterious effects of metrazol, in therapeutic doses, on the transcription of nonsense syllable codes. The number of cases tested was small. In view of the increasing use of metrazol shock therapy in mental disease, further work in this field seems needed.

Other factors—Glick (51) has made the interesting observation that intelligence test scores obtained by Massachusetts State College freshmen during the severe hurricane of 1938 were significantly higher than for any previous class. The investigator was of the opinion that the improved scores could be attributed to the "increased amount of ozone" present in the atmosphere during the testing. This is a hypothesis suitable for an experimental test. In the meantime we already have considerable evidence as to the psychological effects of distraction; if the hurricane exerted an actual influence upon mental test performance, it may have been through facilitation by noise and other distractors rather than through some indirect physiological effect.

Mental Development and Infectious Diseases

Encephalitis—Whether infectious diseases affecting chiefly the central nervous system result in impairment of mental development seems to depend on many unknown factors. For instance, among children with encephalitis, Bender (9) reported marked retardation in the mental abilities revealed by the Goodenough ("drawing a man") test, although Binet IQ was only slightly reduced. For the six cases studied (ages nine to fourteen years) the outstanding features were (a) overactivity, (b) inability to inhibit impulses, (c) limited span of attention, (d) tendencies to come in contact with persons and things by clinging to adults, (e) overaffectionate or aggressive behavior with other children, and (f) touching, handling, or destroying things. These behavior traits were attributed to perceptual difficulties in relation to the subject's own body, reflected in the inability to draw a man. Bender concludes that this is a special disability and is not related to general intellectual impairment. Brown, Jenkins, and Cisler (28), however, found a decrease in average intelligence quotient from one examination to another (average 1.4 points per year) in a group of 108 encephalitic patients (aged two to twenty-six years at first examination). There was some evidence that the progressive decrease in intelligence was somewhat greater in children subjected to the disease before the age of ten years than after. Unfortunately, no series of cases is available in which mental tests were made on patients prior to the disease, so that the

inference of intellectual impairment resulting from the disease must be based on the progressive decline of IQ during chronic disease states. Lord (78) has cited examples of cases in which mental impairment, as reflected in interference with learning to read, followed severe measles, encephalitis, or double mastoid infections. No evidence for depression of mental development following poliomyelitis was found by Gordon, Roberts, and Griffiths (54) in a study of Binet IQ in 98 cases (aged four to sixteen years).

Syphilis—The effect of syphilis on mental development is difficult to evaluate because of possible selective factors. Even though a positive relationship may be demonstrated between the incidence of syphilis and mental defect (58, 84, 88, 139), we cannot be sure to what extent this is due to the tendency for duller individuals to expose themselves to infection and to neglect adequate prophylactic measures. Jenkins, Brown, and Cisler (65) studied Binet IQ's obtained on repeated examination of syphilitic children and nonsyphilitic sibs. An average IQ difference of 11.2 was found in favor of the nonsyphilitics; the difference increased on retests, leading to the conclusion that syphilis in childhood has a retarding influence upon mental development. Other studies have come to similar conclusions. Bazeley and Anderson (7) and Kiss and Rajka (68) have reported that early and intensive treatment for the disease, beginning before the age of six months, will prevent mental retardation. Their evidence on this point cannot be said to be fully adequate.

Tuberculosis—Schultz (116) found no intellectual differences (as measured by the Pressey tests) between adult tubercular patients in a sanatorium and a "representative group in the normal population." Moorman (89) quotes semiscientific and popular opinions which support his clinical observations of striking mental excitations accompanying tuberculosis, especially in those with superior mental abilities. The hypothesis that the tubercle bacillus produces a substance which acts as an excitant to the central nervous system is less attractive to the reviewers than the simpler assumption that greater mental output in tubercular patients, if it exists, is the result of heightened motivation in the face of physical handicaps and enforced inactivity.

Allergy; Heart Disease; Conclusions

The clinical impression that allergic children are more intelligent than normal ones has not received confirmation in quantitative studies (35, 99, 129). When personality questionnaires were administered to 139 allergic children as compared with 117 normals, Riess and De Cillis (106) reported greater "ascendancy" among the allergic group. Insignificant differences in the direction of increased extroversions and emotional instability of the allergic group were reported in the same study. These results are not in accord with those of Chobat, Spadavecchia, and De Sanctis (35) who studied a group of twenty girls and forty-five boys and concluded that

"allergic children show all degrees of ascendancy and submission, extroversion and introversion, the tendency being slightly toward submission and introversion for the group as a whole." In view of the small differences reported and the lack of agreement between the studies, it seems justifiable to doubt the existence of any general differences in personality traits of the allergic and nonallergic.

The conclusion of Ross (108) that "the intellectual endowment, as measured by the Binet-Simon intelligence tests, tends to be somewhat lower in the group (of patients) suffering from congenital heart disease" has no justification on the basis of the evidence offered. The data consist of Binet-Simon intelligence test scores of 22 cases (age five to twelve years) of congenital cardiac disease from the Harriet Lane Home. The analysis consisted merely of comparing the frequency distribution of the IQ's of the 22 cases with that of 1,000 cases over the same age range selected from the same institution. A more adequate statistical treatment indicates no significant differences.

By way of summary for this concluding section, it may be said that impairment of mental function and alterations in behavior do accompany diseases in which physiological alterations are known to take place in the central nervous system itself, as in encephalitis. Present information is, however, inadequate to predict the direction or degree of impairment which may be expected in any given case. While hereditary syphilis may interfere with mental development in young children if left untreated, there is no good evidence that alterations in intellectual development tend to accompany diabetes, tuberculosis, diseases of the heart, or allergies.

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CHAPTER IV

Intellectual Changes during Maturity and Old Age¹

IRVING LORGE

THIS REVIEW of intellectual changes during maturity and later has been prepared in terms of the educational need to understand the psychology of the adult. The increasing percentage of older individuals in the United States and the augmented interest in the education of the adult in and out of school are accepted facts. This review will attempt to consolidate the information about intellectual changes from 1936 through 1941.

Reviews

A critical review of the area of adult intelligence up to 1936 has been made (96). Miles (73) also critically appraised the psychological aspects of the aging process, indicating changes in usual interpretation. Lawton (61) surveyed the literature on mental abilities at senescence. Additional reviews are available (21, 25, 56, 82).

Tests of Adult Intelligence

Two tests specially developed for measuring adult intelligence are now available (13, 95). The Babcock and Levy (13) revision of the Babcock test is based on the level efficiency theory (9, 11), whereas the Bellevue-Wechsler tests attempt to measure "the global capacity of the individual to act purposively, to think rationally and to deal effectively with his environment" (95) and also to appraise mental deficiency (15). Guilford (50) revised the Army Alpha test on the basis of factor analyses; Hovland and Wonderlic (54, 102) revised the Otis Self-Administering Test of Mental Ability in terms of an item analysis based on adult responses in the Personnel Test. Lorge (67) prepared a table of percentile equivalents for eight intelligence tests commonly used with adults. Benton (19) showed the influence of Hutt's revised scoring in appraising the performance of adults. Cattell (32, 33) claimed the development of a test freed of cultural influences. Price (78) suggested and developed a discriminating directions test for use with adults. Mitchell (74) showed that higher IQ's are obtained for adults with the 1937 revision of the Stanford-Binet than with the 1916 edition.

Developmental Limits

Freeman and Flory (42), on the basis of repeated tests of an identical population up to age nineteen, found the terminus of intellectual growth

¹ Bibliography for this chapter begins on page 557.

as measured by the VACO tests could not be determined but was not earlier than age nineteen. The group, however, was a superior intellectual group—1916 IQ was 115. Wechsler (95) suggested the limit of intellectual growth as not far from age fifteen, although he stated that "the age of maximal functioning mental ability falls between ages 22 and 25 years." Miles (73) discussed the relation of speed to power intelligence tests and its implication on terminus of intellectual development. Davidson (37) reported a correlation between intelligence tests given ten years apart for a group of employed adults as .89; for subtests for the Bureau VI opposites, .81; verbal relations, .65; number series, .71; and information, .81, indicating the relative stability of the components of an intelligence test. Pintner and Stanton (77), using the CAVD, reported that the intelligence growth curve tends to be parabolic rather than a straight line.

Prediction of Intellectual Status

Several studies showing the relationship between childhood or adolescent status in intelligence and subsequent adult status have been reported. Adams (1) showed that children who go to college have a childhood IQ of 112 as contrasted with 97 for those who do not. Ball (16) indicated that childhood IQ is positively related to subsequent adult occupational level. Baller (17, 18), comparing adults having childhood IQ's under 71 as contrasted to a matched group having childhood IQ's of 100-120, showed the duller group as having prolonged attendance in school, seven times the control group's death-rate, less employability, and greater criminalism. Brody (23), reworking studies (92) and (96), found a closer relationship of achievement to years of schooling than to intelligence, although (96) and (92) reported the interpretation that intelligence is basic to achievement. Terman and others (69, 81, 93, 94) reported that superior status on intelligence in childhood is indicative of superior status on such tests in adult life, high personality ratings, and good standing in college, although a considerable number had not lived up to their ability.

Special Groups

Brown and Hartman (26) surveyed the intelligence of adult prisoners, finding approximately the same average for them as for the Army Alpha draft, a wider dispersion, and a disproportionately greater number of mentally retarded and defectives, although the same proportion of superior intellects as in the general population. Henry and others (35, 52, 53) have made surveys among CCC enrollees; a survey of mental ability in a rural community has been reported (72), and several appraisals of intellectuality among college extension and evening students (70, 71, 92). Wells and others (99, 102), studying one hundred superior men of sharply contrasted incomes, found no statistical differences in intelligence, vocabulary, or personality.

Mental Efficiency and Mental Deterioration

Perhaps the most significant generalization emerging from the literature (57) on intellectual change is the differential decline of vocabulary, information, and verbal tests as compared with performance tests. Babcock (13), utilizing the hypothesis "the first law of mental deterioration is that the oldest learning is last to be lost," developed a test whereby intellectual level is estimated from vocabulary and performance on other tests contrasted with it for level. A discussion of this hypothesis is to be found in her book and articles (9, 10, 11). Additional evidence is to be found in Gilbert's work with the Babcock-Levy tests (45, 47). Yacorzynski (103) indicated, however, that the theory is not sound, even though, operationally, the test discriminates levels of mental functioning. He pointed out that the crudity in scoring the vocabulary test is the primary reason for the apparent stability of vocabulary. Rabin (79), using the Bellevue-Wechsler test, concluded that the process of mental reduction in senility differs from that of schizophrenia. Youtz (104) has confirmed experimentally Jost's laws which are related definitely to the Babcock hypothesis, namely, "Given two associations of the same strength but of different ages, the older one has the greater value on a new repetition; . . . the older falls off less rapidly in a given length of time."

Capps (31) showed that vocabulary decreases with the degree of deterioration in idiopathic epileptics, indicating clinical shrewdness in appraising level from vocabulary. Jastak (55), however, showed vocabulary relatively unaffected in post testing after insulin shock therapy of schizophrenics. Harbinson (51), using Terman vocabulary tests and visual perception tests, found deterioration in melancholias to a greater degree than among schizophrenics. Shipley (86) has made an ingenious self-administering scale for measuring intellectual deterioration and impairment. It can be said that the estimation of deterioration rests upon a reliable and valid measure of vocabulary level.

Vocabulary

Shakow and Goldman (85) showed the increment of vocabulary scores from age eighteen to age fifty and beyond in groups differentiated by amount of schooling. Christian and Paterson (34) surmised a steady increase in vocabulary from age eighteen to forty with the possibility of a slight increase up to age sixty or seventy in superior adults. Atwell and Wells (8) developed and standardized wide range vocabulary tests and suggested that precision vocabulary levels are lower than wide range recognition vocabulary levels suggesting the implications already referred to (104). Atwell (5) showed that the level of the 1937 Terman vocabulary is generally higher than that obtained from the 1916 list. Brody (24) has revised the 1916 Terman vocabulary for British subjects finding characteristic differences in approach to the test. Such characteristic differences in approach have been appraised experimentally (20).

Memory

Gilbert (46), using Babcock-Levy tests, found, in comparing persons aged sixty to sixty-nine with persons aged twenty to twenty-nine matched for vocabulary level, a loss for the older group in each of eleven tasks involving memory. The losses range from $8\frac{1}{2}$ to 60 percent, depending upon the task. When the memory losses of the brightest young and old are contrasted, the old losses are relatively smaller, ranging from 5 to 36 percent. Gilbert (44), comparing children with adults in the age range thirty to sixty-five, found the hedonistic tendency in memory to be more potent among adults. Shakow and others (84) studied the memory function in normals in order to evaluate memory in psychoses. They reported the curve for the normals as showing "flatness through the 50's and a drop beginning in the seventh decade" and that old versus new recall is definitely related to age in the normals. Kubo (58), however, reported that rote memory did not show a sudden drop until age eighty-two.

Speed and Level

Lorge (62, 66), however, indicated that many of the reported declines in ability are attributable to the measurement of abilities by means of tasks in which speed and power are indiscriminately mixed. Goldfarb (48) showed that speed, experience, and intellect are mixed in the Bellevue-Wechsler. Brown (27) indicated that young adults excel on speed tests although they cannot be distinguished from older adults on a power test. Copeland (36) and his unpublished data indicated that, on the Otis S-A taken under work limit conditions, younger adults take less time to complete the task but the scores are approximately equivalent in the age range fifteen to fifty-five.

Factor Analysis

Balinsky (14) made a Thurstone factor analysis of nine tests of the Bellevue-Wechsler for age groups nine, twelve, fifteen, twenty-five to twenty-nine, thirty-five to forty-four, and fifty to fifty-nine, found no consistent pattern, and concluded that mental tests measure different weighted composites of intellectual ability in different age groups. The implication is clear that evaluation of mental status must be in comparison with normals in the same age range. Goldfarb (48) has made a factor analysis of reaction time, the ten tests of the Bellevue-Wechsler, and speed tests finding at least three factors by the Hotelling method. Altman and Shakow (3) attempted to measure the discrepancy between vocabulary and the 1916 Stanford-Binet (without the vocabulary), as a function of age and other variables. In normals, they found the association to be about zero.

Learning

Most of the material about the learning of adults indicated that adults' learning processes are like those of children, Lorge (63, 64, 65, 68) stress-

ing speed-power relationship and Freeman (39) stressing interests and willingness to learn. Snoddy (90, 91) reported differentiation of facilitational and adaptational aspects in learning of adults. Richards (80) indicated a greater difficulty in unlearning invalid behavior patterns of adults as compared with children. Yokogawa reported to the Sixth Congress of the Japanese Psychological Association (1938) that learning is at a maximum at ages fifteen to nineteen with twenty to twenty-four as next best on speeded tasks. Smeltzer (89) indicated modifiability of younger adults and Ruch (83), the characteristic loss of adults on performance tests.

General

Achievement—Buswell (28, 29) has studied the reading ability of adults; Witty (101) blamed the schools for the reading habits of adults; Norris (75) indicated that adults improve in their abilities in language skills while losing in numerical skills as they grow older. Cameron (30) suggested a genuine difference in thinking processes of older individuals. Goldstein and others (4, 49) suggested that adults in general comprehend heard materials better than read materials, although the differences are not maintained for more difficult material.

Cautions—In appraising intellectual change with advancing age, practice effects must be considered (2, 97, 98), the social milieu of the adult appraised (59), the kind of test items given the adult evaluated (22, 54). In addition, Simon (87, 88) suggested that tests developed for children are not necessarily valid for adults and hence that the mental age concept be abandoned in interpreting the test results of adults.

Technic—Freeman and others (40, 42, 60, 66) indicated the need of a genetic or longitudinal study as contrasted with the age or cross-section method. The only way to determine intellectual change is in the follow-up of an identical population.

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CHAPTER V

Motor Development from Birth to Maturity¹

NANCY BAYLEY and ANNA ESPENSCHADE

IN THE FIELD OF MOTOR DEVELOPMENT during the last few years attention has been focused primarily on studies of the early stages of neuro-muscular development, on studies of age changes and developmental sequences in motor coordinations, and on the standardization of tests of motor skills. There have also been a number of analytical studies concerned with the nature and components of motor abilities.

Neuro-Muscular Development in Infants

McGraw has published a series of articles (54-66) based on her researches in the "Normal Child Development Study of Columbia University." Her data were obtained from analyses of cinema records and protocols of observations of large numbers of infants, supplemented by a few cases who were observed at frequent intervals during their first few years of life. She has compared these behavior analyses with studies on neural development and the onset of cortical control, and offers impressive evidence that the reflex activity of the neonate is subcortical in origin and that as the cortex develops many reflexes disappear when voluntary motor coordinations take their place. The various motor skills cannot be learned until the appropriate neuro-motor functions have matured sufficiently. McGraw's studies have been concerned with sequences of development in the following observed behaviors: rotary-vestibular reactions (55), response to startle (59), crawling and creeping (54), bladder control (57), reaching-prehensile behavior (58), postural adjustments to an inverted position (63), swimming behavior (66), and achievement of erect posture (60). All these developing motor coordinations have been classified into from four to eight successive but overlapping stages of maturity which are shown to be in accord with cortical maturation. Some of these developing behaviors are also presented in motion-picture films: swimming (64), development of sitting posture (62), and assumption of erect posture (61). McGraw has also presented a statement of her theoretical assumptions (53) and has written a nontechnical article (65) applying some of the principles which have appeared from these studies.

The researches of others on young infants are in general in agreement with McGraw's studies and conclusions. Among these are the studies of Goldstein (34), Goldstein and others (35), and Hunt and Landis (39) on the Moro reflex and the startle pattern. Wagner (92) studied in detail

¹ Bibliography for this chapter begins on page 568.

the body jerk in the newborn. Stirnimann (90) observed stepping movements in seventy-five infants from three to five months of age and found that these movements were neither related to the method of delivery nor to the child's stage of development. Weisz (95) tested equilibrium reactions of children aged two months to eleven years and found their developmental changes to be related to onset of sitting, standing, and walking. Ribble (78) observed variations in the "instinctive" reactions of newborn babies. Schmeidler (82) observed the relation of fetal activity of one infant to the activity of the mother.

Several studies concerned with early motor development have come from the Yale Psycho-Clinic. Ames has, by the study of cinema films, found precursor signs of plantigrade progression (3) and relationships between stair climbing and prone progression (2). She also found consistency over a period of time for the same infants in speed of motion and skill in creeping, climbing, and prehension (1). Gesell and Ames (30) were able to discriminate, by cinema analysis, twenty-three different stages in the process of attaining upright locomotion, and found that infants progress through about eight cycles of dominance of the flexor and extensor muscles, and similar cycles of bilateral and unilateral dominance in the development of locomotion.

Bergeron (6) has found unilateral movements in infants during the first three months. Friedjung (25) divides activity and control of the hands into two periods, before and after they are free from use in locomotion, and stresses the need for satisfying the infant's normal urge to touch and handle objects.

Later Age Changes and Sex Differences

The studies of developmental changes which occur in various types of skills and motor coordinations may be divided into longitudinal studies, involving repeated observations on the same subjects as they grow older, and cross-sectional studies in which the performances of different children varying in age are compared.

Most of the recently reported longitudinal studies give data on small numbers of cases. McGraw (56) retested Johnny and Jimmy to discover the extent to which early training in skills remained effective at school age. Some skills were retained better than others. She concluded that the maintenance of acceleration in a skill is determined by its degree of integration and stabilization at the time training ceased, on growth changes in body size and proportions, and on attitudes toward the activity. Weinbach (94) fitted an equation to the speed of climbing inclines of differing degrees of steepness as observed for one infant from six months to two years of age. He concluded that there is an optimum angle of 24° and an optimum load of 40 percent of body weight which remains constant with advancing age.

Jones (43) observed twenty-four children from twenty-one through forty-eight months of age in their play with wheel toys. She found that the level of performance was in large part a function of maturation, but that opportunities for practice and several other environmental conditions affected the development of skill. There were also definite sex differences. Bayley (5) reported briefly on the motor development of her growth study cases from birth through ten years.

Age changes in physical strength of adolescent girls were reported by Pryor (76). Tests designed to measure especially coordination, speed, accuracy, and strength were given to 165 adolescent boys and girls by Espenshade (24). These tests were repeated on the same children for seven consecutive school semesters. Mean performance of boys increased steadily and markedly throughout the age range studied, but those of girls in some events reached a maximum at fourteen and declined thereafter. Sex differences were apparent at all ages but were greatest in older children.

There are a few cross-sectional studies of developmental changes which do not present results of standardized tests. Gutteridge (37) made observations on motor play of children two to seven years of age in free play at home and school, and concluded that the usual equipment provided for such play is not adequate for the children's abilities. Wild (97) described the manner of throwing a ball used by children two to seven years of age. Her conclusions about age changes and sex differences are suggestive, but the number of cases is entirely inadequate for this cross-sectional type of treatment. Keeler (44) reported that physical skill of boys, as measured by the Johnson test, increased through school Grades V to XII. Apparently a maximum is reached at chronological age sixteen, and this level is maintained through age twenty. He tested approximately nine hundred boys but reported his findings inadequately in general statements. Grinstead (36) found that the amount of observed movement in the school room decreased with increasing age and IQ. Van der Lugt (48) studied the development of manual dexterity.

The effect of rotation upon boys and girls five to twenty-one years of age was studied by Russo and Dallenbach (81). Children under eleven years tended to enjoy the test more than the older ones. No sex differences were found. Men exceeded women in the initial and final level of skill demonstrated on the Koerth pursuit rotor (12) but women gained more during rest periods. A normative study by Howland (38) on high-school girls indicated that improvement in skill and strength events occurred with age but that jumping ability showed a decline. An investigation of records of professionals in sports showed that the age of optimum performance in combative type games (as football) is twenty-four years; for games of skill (as golf or baseball), twenty-eight years (47).

The subject of motor development in childhood and in adolescence was reviewed by Jersild (41) and the fragmentary nature of the experimental evidence was pointed out.

Measurement of Motor Abilities and Aptitude

Data showing age changes or individual differences in motor skills may be arranged to form standardized test scales, and a number of such tests have been published in the past three years. Some of these are for young children, some for school children, and some for college students. As a rule the scales do not extend over more than one of these three areas.

The field of measurement in gross motor performances has been defined and past research summarized in a recent book by McCloy (51) and in the revision of Bovard and Cozens' text (8). Powell (71) has summarized the present status of physical indices. The Johnson physical skills test, devised as a means of classifying activity classes into homogeneous units (42), has been studied as a possible measure of motor educability (67, 45). The criteria for evaluation have been weak so no conclusions have been reached. Carpenter (15) adapted the Johnson-type tests to the measurement of motor educability in the first three grades. She also presented a battery of tests for measuring speed (14) in the same grades. Her selections were determined by factor analysis of intercorrelations on a battery of tests. A recent study by Brace (9) in the field of motor educability reported a low correlation between the Brace test and the learning of simple motor acts. Tests of agility have been devised and have proved of value in the homogeneous grouping of boys for physical activities (26, 93). The tests are easily and rapidly administered and provide a practical tool for rough classification.

The Gesell tests for the first five years (28, 31), which include motor development, have recently been republished with more detailed directions for administering and scoring. Crider (18) described a simple tapping test and gave tentative norms for five through eleven years.

The measurement of motor ability of girls and women by means of events such as running, jumping, and throwing was reported by Powell and Howe (75) and by Scott (84). This type of test predicted motor performances of girls more accurately than did strength measures. This is equally true for college men according to Cozens (17) and to Sperling (88) and for high-school boys according to McElroy (52). Some strength measures combined with athletic events form the most satisfactory type of test battery. The value of the Sargent jump in predicting the ability of high-school boys to develop power was demonstrated by Van Dalen (91).

A group of studies from Wellesley College on "Neuromuscular Function and Development" (72) has been published. Measures of reaction time with choice, of hesitation time, of alertness, and of coordination were studied and their relationships to gross motor performance examined. The average correlation between these measures and gross motor acts was of the order of .3. Progress in the measurement of achievement in specific activities has been summarized in Glassow and Broer's book (32). McCloy (51) and Bovard and Cozens (8) also reported a number of such studies. The greater part of recent studies in this field has been done on college

women (23, 33, 83), although some work with younger girls has been reported (80).

Influences of Culture and Environment

Dennis (19, 20, 22) observed Hopi Indian children and compared them with white children in such developmental behaviors as first sitting, standing and walking, and manipulation of toys. Hopi infants who were kept bound on cradle boards for from three to six months were not retarded when compared with other Hopi and Navajo infants who had not been bound. In age at onset of walking, the Indian infants are slower than various groups of white infants reported in the literature. It could not be determined whether this is a racial difference or due to other, nongenetic, factors. Dennis also reported observations on two white infants whose first seven months of life were spent under conditions of restricted practice (21). They were found to be not significantly different in their development from infants living in normal environments. Peatman and Higgons (69) tested a selected group of infants with optimal pediatric care and found them to be accelerated in onset of sitting, standing, and walking. The acceleration might be a matter of genetic selection or of superior care and environment.

Gesell (27, 29) reported on a diary made of a child who was found in a wolf's den. He concluded that the child had shown remarkable ability in adapting to quadruped progression and other wolf-like behavior, but that the strength of her human nature was evident in her re-education during her life in the orphanage. It required years for her to attain upright walking and she always reverted to all fours when running.

Skeels and others (87), comparing orphanage children with and without nursery-school experience, found that the preschool children developed faster in motor achievements where they had greater opportunities to practice. Jones (43), as already noted, also found greater skill in play with wheel toys among children with favorable conditions for practice.

Relation to Other Factors

A detailed study of the physical, mental, and "citizenship" qualities of high-school boys has been reported by Ray (77). Boys who participate in athletics are among the superior group of the school in IQ and academic grades, in health, and in the holding of positions of leadership. The relationship in college women between physical and mental ability is slight according to Wellesley College studies (73). Nor can any significant relationship be shown between physical ability and the size of the sub-costal angle, or the judgment of distance.

✓ The effect of undernourishment upon strength can be demonstrated by testing children six to twelve years of age (68). The degree of undernourishment is not significantly related to performance, however. In tests of skill no differences according to nutritional status could be found. Peat-

man and Higgons (70) reported that heavier infants do not as a group stand or walk later than lighter infants. Espenschade (24) found that boys who scored highest on motor tests were anatomically more mature and stronger than the boys who scored lowest. The girls who scored highest tended to be of slender build with little subcutaneous tissue, as compared with the girls making low scores. Stanton (89) compared deaf children with a control group of similar socio-economic status on the Minnesota Mechanical Ability tests and found that the two groups were similar, though both were below the norms established for children of higher socio-economic status.

The Nature of Motor Ability

Within the past three years a number of analyses of motor skills by factor methods have been made. In an investigation of fine motor skills, as steadiness and tapping, Buxton (10) found very low relationships between tests and narrow group factors only. Further studies by Seashore (85) and Seashore, Buxton, and McCollom (86) identified certain group factors, namely, strength, speed, and precision. These authors stated that the factors identified seem to correspond to "qualitative similarities in pattern of action rather than to anatomical units" and recommended motion study rather than statistical methods for further research in this motor field.

An exploratory study by Bass (4) on static and dynamic balance yielded nine factors of which only five were tentatively identified. The importance of the eye in balance is clearly demonstrated and the weighting of tests in the various factors suggests that the eye has several specific functions in balance.

Analyses of gross motor ability by theoretical and experimental methods have been reported by Powell (74), McCloy (49, 50), and Wendler (96). All agree that strength, speed, and coordination are important elements of motor performance. Other factors have been less consistently identified. Richards and Nelson (79) applied the factor analysis technic to the Gesell tests administered to eighty infants at six, twelve, and eighteen months of age and found an "alertness" factor and a "motor" factor present at all three levels. A formula for the measurement of "dynamic strength" in college men has been given by Larson (46) and for "pure strength" in women by Carpenter (13); for "pure speed" or velocity by Hutto (40) and by Coleman (16).

Summary

In general, the recent researches summarized in this chapter show that during the first few years of life maturational factors are of primary importance in the development of motor coordinations; that in the neonate coordinations are reflex in nature and under sub-cortical control. With development of the cortex, voluntary motor responses emerge, and the

order of their maturing is in a cephalo-caudal direction (30, 53). Although the development of motor ability is dependent upon maturation, the acquisition of skill is influenced to a great extent by practice. Differences in performance, however, may be due not only to differences in opportunity for practice but to freedom from inhibitions and to the child's attitude toward the activity.

A variety of standardized tests have been reported for the measurement of these marked individual differences in motor abilities. Such tests make possible more intelligent provisions of play equipment and provide a basis for more adequate planning of the physical education program. The factors most important in tests of motor abilities are found to be strength, speed, and coordination of movements.

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CHAPTER VI

Physical Growth from Birth to Maturity¹

HARRIET J. KELLEY and JANET E. REDFIELD

The Curve of Growth

BUNAK (20) STUDIED THE FINAL SIZE of the body and the relative growth in different periods. He found no correlation between rapidity of growth, either during adolescence or the whole growth span, and final size of the body. "The relative growth intensity varies within narrow limits and does not change the general type of the human growth curve, which is . . . a parabola of the fourth order." The curves of increments show the same three characteristic phases of decreasing, increasing, and again decreasing velocity over a span of years. Gould (55) concluded from repeated measurements of female college students at Tulane University that shorter students, regardless of age, grew slightly more in college than did taller students. The finding that young college freshmen represent a physically accelerated group was confirmed. The author believes it unsafe to plot points on a growth curve from averages of different sets of individuals, for each person has spurts and cessations of growth in stature that are masked by average values.

Peatman and Higgons (119) discussed the absolute and relative variability in height and weight of their group of privileged New York children in comparison with Woodbury's series. Their subjects were 1,112 boys and girls, one to sixty months of age. Absolute variability in the two measurements increased with age in both groups, with neither sex consistently more variable than the other; the girls tended to be relatively more variable. Factor analysis studies of growth were made by Mullen (114) and McCloy (99).

Growth in External Dimensions and Body Form

Meredith and Brown (109) presented original and comparative findings on growth in weight of the full-term, nonpathological infant during the first two weeks of postnatal life. Their data were seriatim weight values from birth to the tenth postnatal day for approximately 1,000 healthy infants of northwest European descent born at the University Hospitals, Iowa City, between 1930 and 1933. Among their findings were the following: male infants consistently exceeded female infants in mean weight between birth and the tenth postnatal day; throughout this period, mean weight was least for first-born infants and greatest for infants of fifth and higher birth order; day-to-day means showed a loss in weight between birth and three days following birth of 215 grams, or 6.2 percent of mean

¹ Bibliography for this chapter begins on page 584.

birth weight, but with a good deal of individual variation from this pattern; about 26 percent of the infants regained their birth weights by the close of the first postnatal week and about 52 percent of them by the tenth day; infants tended to approximate their birth weight by ten days of age.

Longitudinal growth records of two healthy girls were reported by Gray and Faber (57). Both girls were of "Old American" stock and were reared in excellent environmental circumstances. The data discussed in this paper were seriatim measurements of stature and weight from birth to adulthood, and the actual growth observed was compared with that predicted by various standards. The best basis found for prophecy was the girl's position in a private-school series in terms of the standard deviation. Weight sometimes diverged markedly from standard and might fluctuate from month to month even in the absence of disease or diet.

A modified longitudinal study of stature and weight measurements made on 493 boys and 459 girls who were followed by the Cleveland Developmental Health Inquiry since 1931 was reported by Simmons and Todd (140). Between two and thirteen years of age, stature was a good basis for prediction over annual intervals and weight somewhat less so. Sex differences in mean stature and mean weight were significant under two and one-half years and at twelve and thirteen years. Mean annual increments in stature formed a negatively accelerated curve until eleven years for girls and twelve years for boys, followed by rises. The mean increment in weight of both boys and girls during the first year of life was approximately double the birth weight; it decreased during the second and third years but with the fourth year began a rise that was maintained through the twelfth year. As a measure of growth, stature was found to be superior to weight. "The stature-weight relationship is shown to be too low for employment of either as a criterion of the other. The use of the age-weight-stature table in individual appraisal is therefore discouraged."

Components of Stature

The growth of the three major components of stature—head and neck, trunk, and lower extremities—was investigated by Meredith (106). The data consisted of approximately 2,700 values for each dimension, obtained on 740 children of northwest European descent between seven and seventeen years. Trends in growth, changes in proportion of mean stature, and the interrelation of the three dimensions were studied. Van Dusen (154) studied the relative size of the upper extremities in children and adults. Donelson and others (43) reported measurements of 1,013 college women from the states of Iowa, Kansas, Minnesota, Ohio, and Oklahoma. Four hundred and thirty-seven of the subjects were "Old Americans." The measurements taken were height, weight, chest breadth and depth, girth of the arms and left leg, and pressure of the right and left hands. Among the findings were: "The means for the Old Americans were slightly smaller for all measurements than the means for those not classed as Old Ameri-

cans, with the exception of the chest breadth and depth which were no different; the girth measurements were significantly smaller. . . . The women measured for this study excel in height and weight previously measured college women from the respective states."

Goldstein (53) investigated the changes in the dimensions and form of the head with age in the same individuals. Length of head showed a high annual increment between two and five years, a sharp drop until seven, a plateau with pulsations of growth until thirteen years, followed by acceleration in males and deceleration in females. Increment was more a function of age than of initial size. A high increment one year was generally followed by a lower increment the next year. A definite relation was found between head growth and menarcheal age. Marked changes of cephalic index may occur in the same individual in the course of time: "A substantial proportion of cases—over 30 percent between six and seventeen years—change from one index category to another during the course of growth and development. The most common transition is from brachycephaly to mesocephaly." Davenport (32) discussed the marked changes that occur in the proportion of head height to head length in the fetus, infant, and child, and their dependence on environmental and genetic factors.

Growth changes of the face from birth to eight years, based on serial roentgenograms, were reported by Brodie (17). Atkinson (7) presented stages of growth of the mandible and maxilla. Data on the development of the nose from conception to maturity were given by Davenport (33). Goldstein (52) studied the development of the bridge of the nose through measurements of five hundred Hebrew males between three and twenty-one years, and of fifty old men. Transverse impressions of the bridge were obtained by means of a profile gauge; the tracings of these were recorded, and the widths measured at 2, 6, 10, 15, and 20 mm. from the apex.

A series of studies of pelvic type by Roentgen pelvimetry was published by Greulich and Thoms (58, 59) and Greulich, Thoms, and Twaddle (60). They found no typically "male" or "female" pelvic index. "The type of pelvis that is described in textbooks of anatomy and of obstetrics as the 'normal' female pelvis was found in only 15 per cent of 582 primigravid white women from the obstetric clinic of the New Haven Hospital, 5.7 per cent of 104 student nurses who were of somewhat different racial stock and a much more privileged economic group than the clinic women, and 8.5 per cent of 107 young girls who ranged in age from five to fifteen years. Only 32 per cent of the 686 adults of this series had the type of pelvis which, according to the anthropologic literature, is proper for white women."

Factors Conditioning Growth

Geographic and temporal factors—Reviewing the Harvard Growth Study data, Shuttleworth (136) found that certain years are good growing years while others are poor. Mills (113), Hoffman (65), and Etheredge and Judah (46) observed a tendency toward a decline in height and other

physical measurements from one year to another. Mills compared 607 students at the University of Michigan in 1899-1900 with 1,178 students in 1938; Etheredge and Judah observed yearly changes in height and weight from 1917 to 1937. The *Journal of the American Medical Association* (76) noted no differences in the 1885-1908, 1909-1927, and the 1922 and 1934 groups. Perhaps the decrease observed in college students is due to changes in population produced by such factors as race and socio-economic status. In Lloyd-Jones' study (94) of 100,000 boys and girls, ages six to eighteen years, the California-born were taller at every age (the average difference being about 1.27 cm.) than those born elsewhere.

Holmes' study (66) of Japanese migrants to Hawaii indicates they are, on the average, heavier than the sedentes, their shoulders are wider, trunks shorter, legs and distal arm segments longer, and their chests are broader but shallower. Their heads are higher, with wider bigonial diameters and longer total and upper face heights. Japanese males born in Hawaii are 4.11 cm. and females 1.71 cm. taller than those born in Japan. In general, the Hawaiian-born deviated from the Japanese residents in the same direction as the regional migrants but to a still greater extent.

Race—Schlutz and others (131) found Negroes to be inferior to whites but socio-economic status was not comparable. Steggerda and Petty (149), and Metheny (111) took complete measurements on groups of Negro and white college students and made comparisons by means of the critical ratio. They found differences in certain ratios, measurements, and indices to be significantly different. For the ages five to eleven years, Lloyd-Jones (95) found whites to be the tallest and heaviest; Negroes next; then Mexicans; while the Japanese were shortest and lightest. Jenss (72) found that children of Italian ancestry gained more slowly than those of American ancestry. Meredith (108) obtained similar results in a study of 281 children of North European ancestry and 146 children of Italian ancestry, ages seven to seventeen years.

Heredity—The studies on twins, and particularly MacArthur's study (97) of trends of growth in the Dionne quintuplets, indicate the powerful influence of heredity. The studies of identical versus fraternal twins, as that of Rife (128), compared the influence of heredity with that of environment on physical characteristics. Identical twins reared apart yet so alike physically as were Lois and Louise (51) give us an indication of the influence of heredity on physical status.

Birth Conditions—Illingworth (70) studied records of 150 infants considered as premature because at birth they weighed five and a half pounds or less. Using Holt's standards, 86 percent of the premature group were underweight at one year as compared with 34 percent for a control series. Cole (27) reported that maternal shock increases the loss in weight by the newborn and that factors that tend to retard the second stage of labor reduce this loss. Gray's (56) "big babies," weighing over 4,000 grams at birth, have continued to weigh more than average children of their age during their first two years of life.

Illness—No indication of any general retarding influences of illness on physical growth could be demonstrated by Hardy (61), who correlated eighteen different measurements with frequency of ordinary illnesses during the first twelve years of life of 218 white boys and 197 white girls between the ages of six and thirteen years and 115 white boys and 124 white girls up to twenty years of age, omitting the period of adolescence. Turner and others (153) found that in Grades III, IV, V, and VI children who failed to gain in weight for each of three successive months represented 3.6 percent of the school population. Of these, 70 percent had histories of recent illness.

Obesity—Bruch (18) found that eighty obese children, ranging in age from 2.5 to 13 years, showed markedly advanced stature, skeletal maturation, and early onset of puberty.

Activity—Mateff (104) reported greater gains in height and weight during vacations than during the school year, perhaps owing to season or greater activity. Adams (1) and Beall (13) found activity to be a stimulator of physical growth and certain measurements to be an index of success in certain activities, although the evidence was not conclusive.

Diet—Levine (92) found, in a comparison of children born in the United States versus those born in Holland, Japan, and China, that improved nutrition resulted in increase of growth. Norman (116) reached the same conclusion after comparing five hundred public-school boys on an excellent diet with five hundred secondary-school boys on an inferior diet. In Norman's study the difference in height was chiefly a difference in length of leg. Jeans and Stearn (71) found a greater rate of linear growth for infants receiving an average daily intake of 340 units of Vitamin D than for infants receiving either more or less. Litchfield and others (93) observed that 55 percent of prematures given Vitamin B complex showed a gain in weight during the first week of life, as compared with 8 percent of prematures on average diets. At the age of 2.5 weeks, 95 percent of the Vitamin B complex group showed a gain in weight as compared with 48 percent for the controls. The Vitamin B complex group attained four or five times the birth weight at three months, whereas the controls had doubled or tripled their birth weight at that age.

Pubescence

Shuttleworth (137) analyzed data from the Harvard Growth Study on 747 girls and 711 boys in terms of age at the close of the year of maximum growth in stature and compared these results with those obtained by grouping in relation to menarcheal age. Twenty-two dimensions were studied. The average MG-age for girls was 12.5 years and for boys, 14.8 years. Growth patterns for each sex were similar, but boys showed larger increments and more intense accelerating phases. The inflection points marking the transition between decelerating and accelerating growth and between accelerating and decelerating growth were intimately timed, in the

case of girls, with the advent of the menarche; similar inflection points on the growth patterns of boys might also be timed in relation to significant stages in the process of sexual maturation. Two sets of tables for predicting the average age at menarche for girls between the ages of ten and fourteen years were provided by Shuttleworth (138). The first group of tables is based on present height and weight and gives reliability correlations ranging from .37 to .53. The second tabulation depends on gain in stature and weight in the preceding year; its correlations vary from .51 to .72.

A method of classifying variations in body build in adolescent girls, based on breast development, hair distribution, the sitting height-stature and bicristal-biacromial indices, was devised by Bayer (9). Data on the age at menarche and the characteristics of the menstrual cycles of a group of adolescent girls (11) indicated that those classified as "feminine" in body build reached menarche within a narrower age range and had fewer abnormal menstrual periods than girls of other types of build.

Davenport, Renfro, and Hallock (35) investigated the relation between the basal metabolic rate and growth in weight and stature of fifty-five boys and fifty-five girls over a period of from five to eight years during adolescence. About the same results were obtained whether change in percentage departure from standard basal metabolism or the individual's own base line was used. Most mass correlations were not over $+0.36$; intra-individual correlations varied from -1.00 to $+1.00$. Correlations of change in basal metabolism with change in body weight were somewhat higher than with change in stature; ". . . during the adolescent spurt the increased B.M. processes associated with increasing weight may amount to 10 percent or more of the basal metabolism as determined before and after this spurt."

Appraisal of Physical Status: Build and Weight

Jenss and Souther (73) gave detailed descriptions of the indices commonly used: Baldwin-Wood tables, based on age and height; the ACH (Arm-Chest-Hip) Index of Franzen; Nutritional Status Indices of Franzen; and Pryor's Width-Weight Tables. The four indices were evaluated, using a group of 713 seven-year-old children. There was no agreement among them and not one of the indices was considered satisfactory. Clinical judgment was resorted to but this, too, was unsatisfactory. Jorgensen and Hatlestad (75) also tried to evaluate a number of anthropometric indices; finally they resorted to factor analysis and then concluded that there are no definite types but a continuous distribution of builds from the extreme linear to the extreme lateral. Dearborn and Rothney (39) considered indices a mistake and preferred a prediction equator of normal weight from chest depth, chest width, stature, and bi-iliac diameter. They considered it to be 20 percent more efficient than Baldwin-Wood height-weight tables for fourteen- to eighteen-year-old boys and girls.

One big factor to be considered in determining normal weight and build is that of time required to make the estimate. The ACH Index was developed, not because it was considered a superior method, but because the determination requires less time. In like manner, the percentage index—normal weight as determined by McCloy's standard divided by weight given by the Baldwin-Wood tables—was determined as a substitute for McCloy's prediction equation of four measurements. If physical status were a constant factor it would enable one to correct the Baldwin-Wood normal weight after the McCloy normal was once determined. Metheny (112) tested the percentage index and found that it could be used as a substitute for the second year, but the variability was too great to use it if the interval was more than two years.

Wetzel (159) presented a grid as a short-cut for the use of clinicians. The grid provides a graphical method of relating height and weight. Lines on the grid indicate whether or not the build or nutritional status of an individual has altered.

Dentition

Diamond and Weinmann (41) discussed the formation of normal enamel matrix and its calcification, and disturbances in matrix formation and in calcification. They presented evidence to justify the concept that formation of the enamel matrix is completed before calcification begins and that calcification occurs first at the tips of the enamel cusps. Davis (37) summarized the development of the human tooth, giving tables for deciduous and permanent teeth which list for each tooth the various stages of dentition. Schour and Massler (132, 133) separate the structure of the human tooth into the propriodonal structures (dentin and enamel), pulp, and the paradontal structures (cementum, alveolar bone, periodontal membrane, and gingivae). The tooth passes through four developmental stages: (1) growth, (2) calcification, (3) eruption, and (4) attrition. Before birth (four to six months *in utero*) the deciduous teeth begin the apposition to enamel and dentin in regular sequence, from central incisor to second molar. The first permanent molar is the first tooth of the permanent dentition formed as well as erupted. The bicuspid and second permanent molars begin their formation at 1.5 to 3 years of age, the third molars at 7 to 10 years. It takes from 7 to 14 months for the formation of the crown of a deciduous tooth, while it takes from 3 to 6 years for a permanent tooth. Root formation begins when the crown is completed. The root of a deciduous tooth requires 1.5 to 2.5 years for completion; the root of a permanent tooth, from 5 to 7 years.

Dental Caries

The incidence of dental caries was reported by Klein and Palmer (84) for 1,891 high-school boys and girls, separately, and for age groups from thirteen to nineteen years, inclusive. Blackerby (14) compared the dental

defects of 1,117 Negro children with a group of 11,674 white children considered to be of a similar socio-economic level. Dental care was required by 80 percent of whites and 67 percent of the Negroes. The average number of caries lesions was four for the white and two for the Negro children. Burke (22), Butler (24), Pollia (121), and Roberts and others (129) reported better dental condition for children on the more nutritive diets. Speidel and Stearns (148) found that infants receiving from 300 to 400 units of Vitamin D daily showed earlier eruption than infants receiving either more or less Vitamin D. Klein and Palmer (81, 82), in a study of 4,416 elementary-school children, reported that certain families were characterized by immunity to caries, others by susceptibility.

East and Kaiser (45), Klein and Palmer (83, 85), and Sloman (142) reported articles on the relationship of dental caries to age, sex, or environment. Sloman found the incidence of caries to be significantly higher in girls than in boys, but this rate was reduced for both males and females during middle life. Klein and Palmer found that, considering the tooth age of each tooth, there is no difference between the sexes but that there is a difference for chronological age. East and Kaiser found that caries rate was significantly lower in regions with more sunshine, and that mean winter temperature had only slight influence on the caries rate for all boys and for girls from nine to eleven years of age, but that for younger and older girls it was important. East (44), in a later study of city children, found the same to be true. Bodecker (15) reported a modified dental caries index, which takes into consideration the number of carious or filled surfaces and their areas, and a susceptibility caries index. Palmer and others (117) presented a method of determining post-eruptive tooth age. Massler and others (103) found that from birth to ten months is the period of greatest susceptibility to hypoplastic defects in the enamel and is also the period in which the poorest calcification takes place.

Ossification of the Skeleton

Krogman (89), Wahl (155), Hellman (62), Brodie (17), Atkinson (7), Cohen (26), and Goldstein and Stanton (54) reported changes in the facial dimensions which precede, parallel, or follow stages of tooth eruption. Krogman (89) found that at birth facial dimensions are 40 percent of adult height, 60 percent of adult breadth, 70 percent of adult length; while at five years, 80 percent of adult height, 85 percent of adult breadth, and 85 percent of adult length have been achieved. The remaining 15 to 20 percent of growth is spread over ten to fifteen years. Atkinson (7) reported the mandible at birth as being a more or less thin shell of growing bone, the body of which seems entirely composed of the crypts of the developing teeth, and further reduced to a state of porosity by the abundance of vessels present. Cohen (26) found that for twenty-eight children, studied annually, between the ages of 3.5 and 13.5 years, inclusive, the pattern usually followed was of greatest lateral growth in the dental arch

occurring in the cuspid area. The greatest growth in this area occurs during eruption of the permanent teeth. Goldstein and Stanton (54) investigated 285 children at annual intervals between two and twelve years of age and found that during one year the widths of the alveolar arches manifest decrement or stability in a considerable proportion of the cases, especially between three and five years.

Davenport and Renfroe (34), in a study of roentgenograms of forty-six boys and fifty girls beginning at ten to fourteen years of age and following through to fifteen to eighteen years, reported that sex difference in the areas of sagittal section of the sella turcica appears early. Conel (30) presented a detailed description of the changes which occur in the structure of the cortex during the first month of post-natal life. The growth of the epiphyses takes place, according to Siegling (139), by proliferation of the articular cartilage followed by endochondral ossification. The epiphyseal cartilage is a negligible factor, if any, in longitudinal growth of the epiphyses. The normal hip is vividly described with lines and angles by Burman and Clark (23), for the first year of life. Sontag and others (146) published a table for the number of centers present in the upper and lower extremities for age groups of one month, ranging from one to sixty. The greatest acceleration occurred between twelve and forty-two months for girls and from eighteen to forty-eight months for boys. Pyle and Menino (126), using Flory and Todd's standards, gave findings for children at three- or six-month intervals from birth to five years of age. Bayer and Newell (12) found it difficult to observe six-month-interval differences in many of the series of roentgenograms and advised use of one-year intervals.

Rate of ossification can be hastened or retarded by various factors. Sontag and Pyle (145) reported thyroid deficiency as one factor; Francis (48), that constitutional metabolic disturbances, such as illness, produced a slowing up; MacNair (100) and Roberts and others (129) reported that nutritive factors, such as additional banana or cod liver oil in institutional diets, hasten the rate of ossification. Pryor (125) pointed out that carpal sequence is, to a large extent, controlled by genetic factors. Sontag and Harris (144) found tarsal striae appearing in roentgenograms of one-month-old children, most frequently in roentgenograms of children whose mothers had difficult pregnancies and in instances when the delivery was particularly difficult.

Growth in Body Structure and Internal Organs

Wilmer (161) analyzed the structural components of the body at six lunar months, birth, and maturity, and illustrated the quantitative changes in them. The relative proportion of skin and superficial fat rose prenatally; nervous and skeletal tissues decreased; and the visceral mass and voluntary musculature remained unchanged. Postnatally the muscular component rose; nervous and visceral tissues decreased; and the proportions of skin and fat and skeleton remained unchanged. A similar study was made of skin and subcutaneous tissue in relation to surface area (162). The growth

of bone, muscle, and overlying tissues of the leg area shown in serial roentgenograms was studied by Stuart, Hill, and Shaw (150). Films of the antero-posterior view of the right leg were cut apart and the portions covered by the respective shadows weighed on a chemical balance to ten milligram values. Data from boys and girls between three and eighty-four months of age were tabulated into groups containing between thirty-two and seventy-nine subjects.

The development of the paranasal sinuses from birth to late adolescence was reported by Maresh (101). Tracings were made from routine postero-anterior roentgenograms of one hundred children examined at frequent intervals beginning during the first month of life, in most cases, and continuing over periods of from five to fourteen years. Davenport and Renfro (34) studied the adolescent development of the sella turcica and frontal sinus by consecutive lateral roentgenograms taken over a five-year period between ten and eighteen years of age. Todd and others (152) presented data on the growth in weight of the human eyeball. Growth, in general, appeared to follow brain growth, but final adult weight showed no correlation with cranial capacity. Approximate childhood weight was reached by three years, with a secondary growth period suggested at adolescence.

Comeau and White (29) found a linear correlation between heart volume and body weight and surface, but not body height. In a further study of build and heart size (28), they compared twenty pairs of identical twins with fifteen pairs of unrelated individuals matched for body height, weight, and age. They found a close correspondence in heart size in the series of twins and a somewhat less marked relationship in matched individuals. They concluded that "heart size in normal individuals is dependent principally on body build, and genetic, racial, and environmental factors are usually important chiefly as they affect body structure."

The relation between the size of the thymus shadow and birth weight in 2,000 infants was investigated by Donaldson (42). Some degree of enlargement was found in 18 percent of the cases. The author concluded that the size of the thymus was proportionate to body size. Krumbhaar and Lippincott (91) compiled data on the post-mortem size of the spleen in 4,000 persons. The weight of the apparently normal spleen fluctuated within extremely wide limits. Maximum weight was attained in the sixteen- to twenty-year age period; between twenty-six and sixty-five years the average remained approximately unchanged but thereafter fell rapidly. Hwang and Krumbhaar (69) reported a study of the human appendix in three hundred persons. The appendix as a whole attained its maximum weight about the age of puberty and then decreased throughout the age span more slowly than the lymphatic tissue.

Technics of Research in Physical Growth and Anthropometry

Weinbach (158) proposed that the surface area of the body may be estimated by multiplying twice the girth of the right thigh by the height.

When applied to subjects from birth to eighteen years this method gave results about 2.5 percent lower but very closely correlated with values obtained from the DuBois formula. He also described (157) a method of computing the center of gravity, moment of inertia, and surface area from front and lateral photographs. Burch, Cohen, and Neumann (21) devised a means of measuring small irregular areas of the body by the use of lead discs of uniform diameter and thickness. A cast is made of the part to be measured, the number of discs required to cover the given area determined, and the value computed by weight.

Various technics of measuring auricular height in the living were reviewed by Howells (68) and the reliability of the results analyzed. He recommended the use of an instrument making contact with both sides of the head simultaneously, such as the head spanner. Chattopadhyay (25) criticized Ashley-Montagu's method for locating the nasion in the living adult, maintaining that it could be more accurately determined by palpation. Ashley-Montagu (6) presented data on the reliability of his technic and the difficulties of palpating this landmark. A method of locating the porion in the living was described by Ashley-Montagu (5).

Maresh and Deming (102) studied the pattern of growth of the left humerus, radius, ulna, femur, tibia, and fibula of eighty infants during the first six months of life, as shown by serial roentgenograms and by anthropometric measurements. The mean rates of growth obtained by the two methods were similar, but individual rates of growth calculated from the roentgenograms were less variable than those based on anthropometry. A similar study of the growth of the left tibia from three months to thirteen years of age was made by Francis (49), who also found the two methods comparable.

Further studies in the methodology of anthropometry were reported by Meredith and Goodman (110) and Redfield and Meredith (127). The research usefulness of routine hospital records of length at birth was evaluated by Meredith and Goodman (110). The subjects were one hundred normal white infants measured within twenty-four hours of birth. The mean difference between two independent determinations of length by trained anthropometrists was 2.44 mm., less than one-half of 1 percent of mean stature at birth. For approximately half of the subjects the difference did not exceed 1 mm., and for 92 percent it did not exceed 5 mm. The mean difference between the anthropometrists' measurements and the hospital records was 11.2 mm., more than four times as great. The routine hospital records would be adequate if nothing beyond a measure of central tendency of birth length were required, for the difference between the means of the two series was not statistically significant; but the variability of the group indicated by the hospital measurements was spuriously high, and the measurements of individual infants would be inadequate data for a longitudinal study. Redfield and Meredith (127) found appreciable changes in stature and sitting height of four-year-old children associated with an afternoon rest period. The mean gain in stature with rest was equal to two months' growth for

children of this age, indicating that repeated measurements at bimonthly or quarterly intervals should be made at a constant interval from time of rest.

Sources of error in estimating heart size by the usual roentgenographic methods were discussed by Keys and Friedell (79). On the basis of their technic, which included a kymograph recording, they recommended the equation: Volume = 0.63 (area)^{1.45}. Comeau and White (29) also checked the Rohrer-Kahlstorf formula by measuring the volumes of models constructed from Roentgen measurements, and found errors ranging from -11 to +26 percent in normal hearts. A method to increase the validity of judging posture was devised by Korb (86). Deviations were noted by projecting the silhouette of the subject on a screen painted with lines representing the standard of excellent posture set up by Klein. Reliability coefficients averaged .91 on repeated scoring of fifty silhouettes. Anderson and Cohen (4) found that the inclusion of incomplete series of data in a longitudinal study of dental arch development distorted the underlying trends rather than adding to the significance of the results.

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¹ Corrected to January 1, 1942. Errors should be reported to the secretary-treasurer immediately.

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